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JOURNAL OF PALEONTOLOGY

JOSEPH A. CUSHMAN, Editor

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Volume 2 Number 2

JOURNAL OF PALEONTOLOGY

JUNE 1928

SOME NEW PENNSYLVANIAN OSTRACODA

H. N. CORYELL
Columbia University, New York, N. Y.

ABSTRACT

The new ostracod genera *Seminolites* and *Cavellina* are characteristic of the Pennsylvanian strata of the mid-continent oil fields. The former is presented here with four new species and the latter with seven new species.

A greater share of the responsibilities of discovering and detailing new oil fields has devolved upon the micropaleontologists within the last few years. His labors along these lines have discovered new features of scientific importance; some of which are of large proportions and will require years of time to solve; others are small and easily mastered. The latter are destined to become immediately a part of the working knowledge of many of the students of the oil field stratigraphy. With the minor difficulties turned into useful tools the attack upon the major problems will become more effective and the approach to a possible solution very definitely accelerated.

It is the purpose here and in a series of publications to follow to present some of these minor features and to increase materially the indispensible equipment of a stratigraphic paleontologist.

The genera and species described and illustrated below were secured from collections of the Pennsylvanian sediments of Oklahoma. Their publication has become possible through the courtesy and assistance of the Pure Oil Company in whose laboratories much of the work was done. Additional acknowledgement is here given to Mrs. H. N. Coryell and Miss Frances Charlton for their careful preparation of the mounts and camera lucida sketches.

Family BAIRDIIDAE Brady and Norman, 1892

Genus SEMINOLITES Coryell, n. gen.

Genotype *Seminolites truncatus* CORYELL, n. sp., Wewoka formation, Oklahoma.

Description.—Small, inequivalved, subtriangular ostracods with arched hinge line, highest in the anterior half; the left valve overlaps the right on the entire margin; the ventral edge is nearly straight or broadly convex with curved extremities; the ends of the valves are rounded with a rather distinct truncation of the anterior ventral contact; the surface of each valve is marked by several large irregularly distributed circular pits and a curved ridge near each end that approximately parallels the marginal contacts; a shallow sinus occurs adjacent to the ridge on its concave side.

Habitat.—Marine.

Range.—Pennsylvanian.

SEMINOLITES TRUNCATUS Coryell, n. sp.

Plate 11, fig. 1

Description.—Carapace subtriangular with the apex of the dorsal arch only slightly in front of the median line; the anterior margin is narrowly rounded, the shortest curve near the mid-height; the posterior margin is low, nearly as wide as high; the ventral margin is broadly convex; the surface is ornamented with the terminal ridges and a number of irregularly distributed circular pits; length .61 mm., height .41 mm., thickness .31 mm.

Holotype.—Columbia University Paleontological Collection, No. 25191.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Wewoka formation, Oklahoma.

SEMINOLITES ELONGATUS Coryell, n. sp.

Plate 11, fig. 2

Description.—Carapace lower and narrower than *S. truncatus*, but the highest part of the dorsal arch is farther towards the anterior; the posterior end is very low; the terminal ridges are conspicuous; the rounded pits are segregated in the posterior half of each valve; length .63 mm., height .37 mm., thickness .25 mm.

Holotype.—Columbia University Paleontological Collection, No. 25192.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Holdenville formation, Oklahoma.

SEMINOLITES COMPRESSUS Coryell, n. sp.
Plate 11, fig. 3

Description.—Carapace, long and high; the extremities are more broadly rounded than any species yet described; the marginal outline appears somewhat oval; the anterior terminal ridge and its accompanying sinus on each valve is farther posterior and more broadly curved than in any of the above species; the posterior ridge is near the margin and its presence increases the truncated appearance of the posterior end; the pits are indistinct, rather numerous and somewhat evenly distributed over the surface of the valve between the terminal ridges; length .70 mm., height .44 mm., thickness .25 mm.

Holotype.—Columbia University Paleontological Collection, No. 25193.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Frances formation, Oklahoma.

SEMINOLITES EXTENSUS Coryell, n. sp.
Plate 11, fig. 4

Description.—Carapace, elongate with the highest point of the hinge margin not far from the middle of the anterior half; the anterior end is more narrowly rounded than the posterior; the terminal ridges are present but not conspicuous; the pits are rather numerous and somewhat evenly distributed over the surface between the ridges; length .65 mm., height .40 mm., thickness .25 mm.

Holotype.—Columbia University Paleontological Collection, No. 25194.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Frances formation, Oklahoma.

Family CYTHERELLIDAE Sars, 1865

Genus CAVELLINA Coryell, n. gen.

Genotype *Cavellina pulchella* CORYELL, n. sp., Holdenville formation, Oklahoma.

Description.—Carapace small, elongate, inequivalved; dorsal margin arched; ventral contact nearly straight, slightly convex or con-

cave; anterior end broadly curved; posterior end narrowly curved, the greater acuteness lying above the median line; dorsal view wedge-shaped with the greatest thickness near the center of the posterior one-fourth; right valve is larger than the left, and grooved to receive the left; the margin of the right valve is thickened all around, most on the dorsal and ventral edges; the dorsal margin of the right valve overlaps the left, the ventral and posterior margins extend beyond and appear like a prominent overlap, but the amount of overlap is slight or none at all; the anterior margin is not overlapped, in most cases it is channelled along the contact; the surface is smooth, or finely punctate; within the interior of each valve is a partition that extends inward and partially separates the posterior one-third of the body cavity from the rest; on the inner surface of each valve, lying between the center and the dorsal margin, is a small rounded tubercle.

This genus is distinguished from *Cytherellina* by having the right valve the larger, and from *Cytherella* by the presence of the interior partition and by the position of the greater thickness of the valves lying close to the posterior margin.

Habitat.—Marine.

Range.—Pennsylvanian.

CAVELLINA PULCHELLA Coryell, n. sp.
Plate 11, fig. 5

Description.—Small, subreniform, elongate, gibbous, inequivalved ostracod; dorsal margin arched, greatest height near the center; posterior end acutely rounded; anterior end broadly rounded and deeply channelled; ventral contact slightly concave; ventral profile convex; right valve much larger than the left, projecting broadly beyond the

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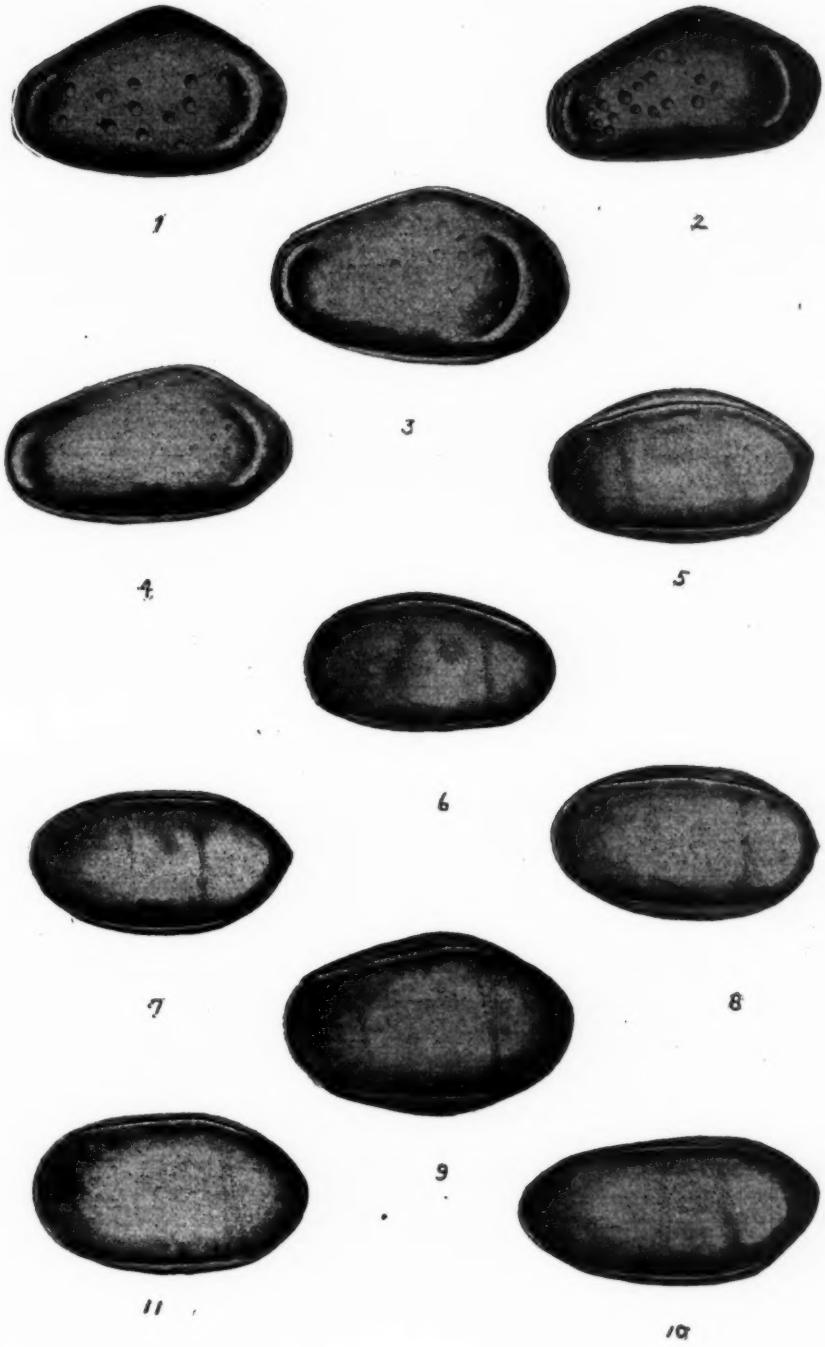
EXPLANATION OF PLATE 11

FIG. 1.—*Seminolites truncatus* Coryell, n. gen., n. sp.
2.—*Seminolites elongatus* Coryell, n. sp.
3.—*Seminolites compressus* Coryell, n. sp.
4.—*Seminolites extensus* Coryell, n. sp.
5.—*Cavellina pulchella* Coryell, n. gen., n. s.p
6.—*Cavellina equalis* Coryell, n. sp.
7.—*Cavellina reversa* Coryell, n sp.
8.—*Cavellina subovata* Coryell, n. sp.
9.—*Cavellina subpulchella* Coryell, n. sp.
10.—*Cavellina minima* Coryell, n. sp.
11.—*Cavellina lata* Coryell, n. sp.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edge of the left valve on the dorsal and ventral margins, only slightly on the posterior, and quite inconspicuously on the anterior; in addition to the posterior vertical partitions within the valves there is evidence of a thickened ridge separating partially the anterior one-third also; interior tubercle prominent; length 1.19 mm., height .80 mm., thickness .40 mm.

Holotype.—Columbia University Paleontological Collection, No. 25195.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Seminole and Holdenville formations, Oklahoma.

CAVELLINA EQUALIS Coryell, n. sp.
Plate 11, fig. 6

Description.—Small, elongate, gibbous, inequivalved ostracod; dorsal margin arched; the ventral contact slightly convex; the anterior end regularly rounded; the posterior end angulated near the dorsal edge; the extension of the right valve beyond the left on the dorsal margin is approximately equal in width from the anterior to the posterior end; the ventral extension is narrow and about the same width along the entire border; the posterior inner portion is distinctly partitioned from the rest of the body cavity; length 1.08 mm., height .67 mm., thickness .42 mm.

Holotype.—Columbia University Paleontological Collection, No. 25196.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Boggy shale, Oklahoma.

CAVELLINA REVERSA Coryell, n. sp.
Plate 11, fig. 7

Description.—Small, elongate, ovate, inequivalved ostracod; dorsal margin nearly straight in the anterior two-thirds; the posterior dorsal contact is nearly a straight line sloping to the acute posterior end that lies above the median line; the ventral contact is somewhat convex, ending posteriorly in a broad curve that terminates in the acutely curved portion of the posterior end; anterior end more broadly rounded below than above; the posterior cavity within the valves conspicuous; length .60 mm., height .30 mm., thickness .30 mm.

Holotype.—Columbia University Paleontological Collection, No. 25197.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Boggy shale, Oklahoma.

CAVELLINA SUBOVATA Coryell, n. sp.
Plate 11, fig. 8

Description.—Small, subovate, inequivalved ostracod; dorsal margin broadly arched; greatest height near the middle and equal to one-half the length; anterior margin broadly rounded; posterior margin showing only faintly the acute curvature; ventral contact straight; right valve extends beyond the edge of the left valve all around and appears to overlap most on the dorsal and ventral margin and somewhat less along the posterior margin; the anterior edge of the left valve is raised from the right, forming a channelled feature; the surface of each valve is smooth; the greatest thickness is near the posterior margin; the dorsal view is cuncate, most compressed near the hinge margin; the posterior position within each valve is conspicuous, thick, and crosses the valve diagonally from the dorsal margin to the anterior ventral edge; the tubercle is present; other thickenings of the valves upon the inside are inconspicuous; length 1.04 mm., height .64 mm., thickness .40 mm.

Holotype.—Columbia University Paleontological Collection, No. 25198.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Boggy shale, Oklahoma.

CAVELLINA SUBPULCHELLA Coryell, n. sp.
Plate 11, fig. 9

Description.—Small, subreniform, inequivalved, gibbous, ostracod; dorsal margin arched; anterior broadly rounded; posterior margin has its narrowest curvature above the middle line; ventral contact nearly straight; right valve much larger than the left, with the greatest projections on the dorsal and ventral margins; posterior partition within the valves distinct.

This species resembles *C. pulchella.* It differs in being shorter, more tapering in the anterior portion; in having a broader anterior extension of the right valve beyond the left and a dorsal overlap and extension of the right valve that is wider farther towards the anterior end; length 1.04 mm., height .72 mm., thickness .45 mm.

Holotype.—Columbia University Paleontological Collection, No. 25199.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Boggy shale, Oklahoma.

CAVELLINA MINIMA Coryell, n. sp.
Plate 11, fig. 10

Description.—Small, elongate, inequivalved ostracod; dorsal and ventral margins straight, converging anteriorly; the posterior ventral margin truncated and slightly concave; dorsal posterior margin very broadly curved; posterior margin narrowly rounded, more acutely above the median line; the anterior margin more broadly rounded, the narrowest portion lying below the median line; the posterior partition within the valves distinct; the anterior thickenings inconspicuously indicated; length .77 mm., height .40 mm., thickness .28 mm.

Holotype.—Columbia University Paleontological Collection, No. 25200.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Holdenville formation, Oklahoma.

CAVELLINA LATA Coryell, n. sp.
Plate 11, fig. 11

Description.—Small, very broad, flattened, subovate, inequivalved, ostracod; dorsal margin arched; ventral contact somewhat convex; anterior broadly rounded; ventral half of posterior margin more broadly rounded than the dorsal; posterior and anterior partitions present within the valves; dorsal and ventral extensions of the right valve beyond the left narrow; anterior margin channelled; greatest thickness near the most narrowly curved part of the posterior contact; greatest height near the middle; length 1.20 mm., height .80 mm., thickness .32 mm.

Holotype.—Columbia University Paleontological Collection, No. 25201.

Habitat.—Marine.

Occurrence and Range.—Pennsylvanian, Seminole and Holdenville formation, Oklahoma.

FOSSILS FROM THE TRINITY GROUP (LOWER COMANCHEAN)

By H. C. VANDERPOOL
University of Oklahoma

ABSTRACT

A typical fauna is shown to exist in certain horizons of the Trinity. The occurrence and relative abundance of the larger fossils along the outcrop is shown by a table. A tabulated list of the smaller (microscopic) forms includes the occurrence and abundance not only along the outcrop but also in the Trinity section of the Sabine uplift area of northwestern Louisiana. Eight new species and two new varieties of ostracods are described and figured.

The Glen Rose and De Queen limestones of the Trinity group, in southwestern Arkansas, southeastern Oklahoma, northern Texas and found in well cores from the Glen Rose formation in northwestern Louisiana.

This fauna is typical in that none of the Paleozoic or early Mesozoic forms carry through into the Comanchean, while, on the other hand, few of the Trinity fossils continue into the overlying Fredricksburg group. The life during Trinity time was essentially shallow water in character, as only near-shore, littoral forms, have been found preserved as fossils in these rocks. The microfauna includes only the more hardy forms, particularly the ostracoda.

The accompanying table shows the occurrence and relative abundance of the larger fossils (megascopic), at six surface outcrop localities in Arkansas, Oklahoma and Texas. Five of the most typical of these forms are figured in Plate 1. All of these occur rather abundantly in both the De Queen of Arkansas and the Glen Rose of Texas. *Ostrea franklini* Coquand and *Glauconia branneri* Hill have been found in well cores from the Glen Rose formation in northwestern Louisiana.

A tabulated list of the species and varieties of microfossils from the Trinity group is here given showing their occurrence and relative

MACRO-FOSSILS OF THE TRINITY GROUP

	Gypsum Bluff, Arkansas	Messers Creek, Arkansas	Dierks, Arkansas	Broken Bow, Oklahoma	Marietta, Oklahoma	Weatherford, Texas
Anomia texana Hill	Common	Common	Occasional	.....	.....	Occasional
Astarte sp. indet.	.....	.....	Occasional	.....	.....	.....
Avicula sp. indet.	.....	Occasional	.....	Rare	.....	.....
Barbatia parva missouriensis Hill	.....	.....	Occasional	.....	.....	.....
Buccinopsis parryi Conrad	.....	.....	.....	.....	.....	Rare
Cardium servierensis Hill	.....	Common	Common	.....	.....	.....
Corbicula arkansaensis Hill	Abundant	.....	Common	Abundant	.....	.....
Cucullaea gratiota (Hill)	.....	.....	.....	.....	.....	Abundant
Cucullaea sp. indet.	.....	.....	Common	.....	.....	Occasional
Cyprina medialis Conrad	Common	Common	.....	.....	.....	Occasional
Eriphyla pikensis (Hill)	.....	.....	Occasional	.....	.....	Rare
Exogyra texana Roemer	.....	.....	.....	.....	Occasional	Occasional
Exogyra virgula Goldfus	.....	.....	Common	.....	.....	.....
Glauconia branneri Hill	Abundant	Occasional	.....	Common	.....	Abundant
Glauconia bittneri (Neum)	.....	.....	.....	Rare	.....	.....
Glauconia sp. indet.	.....	.....	Occasional	Common	.....	Common
Gryphea sp. indet.	.....	.....	.....	.....	Occasional	Occasional
Lunatia pedernalis (Roemer)	Common	.....	.....	.....	.....	Common
Modiola branneri Hill	.....	.....	Occasional	.....	.....	.....
Mytilus tenuitesta Roemer	.....	Occasional	.....	Rare	.....	.....
Natica sp. indet.	Common	.....	.....	Rare	Rare	Occasional
Nerinea sp. indet.	.....	Occasional	Rare	Common	.....	Occasional
Neritina sp. indet.	.....	.....	.....	.....	.....	Rare
Nucula sp. indet.	.....	.....	Occasional	.....	.....	.....
Ostrea camelina (Cragin)	.....	.....	.....	.....	.....	Occasional
Ostrea crenulimargo Roemer	.....	Rare	.....	.....	Occasional	.....
Ostrea franklini Coquand	Rare	Abundant	Common	Abundant	.....	Rare
Ostrea ragsdalei Hill	.....	.....	.....	.....	.....	Common
Ostrea roemeri Quenstedt	.....	Rare	.....	.....	.....	Occasional
Ostrea subspatulata Forbes	.....	Abundant	.....	.....	.....	.....
Pecten duplicostata Roemer	.....	Occasional	Rare	Rare	Rare	Occasional
Pleuromya sp. indet.	.....	.....	.....	.....	Occasional	Rare
Protocardia sp. indet.	.....	.....	.....	.....	.....	Common
Serpula paluxiensis Hill	.....	Occasional	Rare	.....	.....	Occasional
Trigonia sp. indet.	.....	.....	.....	.....	Rare	Occasional

MICRO-FOSSILS OF THE TRINITY GROUP

	De Queen Gyp. Bluff, Ark.	De Queen Messers Cr. Ark.	Glen Rose N. W. Louisiana	Lower Mayine Zone N. W. Louisiana	Glen Rose Weatherford, Texas
Ostrocoda—					
Bairdia dorsoventrus, n. sp.	Common	Common	Occasional	.....	Abundant
Bairdia glenrosensis, n. sp.	Occasional	Rare	Rare	.....	Abundant
Bythocypris rotundus, n. sp.	Common	Abundant	Common	Rare	Abundant
Cypridea diminutus, n. sp.	Abundant	Common	Rare	.....	Occasional
Cypridea tuberculata Sowerby, var. *gypsumensis*, n. var.	Abundant	.....	.....	.....	.....
Cypridea ventrosa Jones, var. *bispinosus*, n. var.	Common	Occasional	.....	.....	Rare
Cypridea sp. indet.	.....	.....	.....	Occasional	.....
Cytheridea trinitiensis, n. sp.	Abundant	Abundant	Occasional	.....	Abundant
Cythere ornata, n. sp.	Occasional	Occasional	.....	.....	Occasional
Paracypris weatherfordensis, n. sp.	Common	Common	Occasional	Rare	Abundant
Pontocypris perforata, n. sp.	Rare	Rare	Occasional	Rare	Common
Foraminifera and other forms—					
Glauconia branneri Hill	.....	.....	Occasional	.....	Occasional
Massilina sp. indet.	.....	.....	Occasional	.....	.....
Nerinea sp. indet.	.....	.....	Rare	Common	Occasional
Orbitolina af. *texana* Roemer	.....	.....	Occasional	.....	.....
Quinqueloculina sp. indet.	Rare	.....	Common	.....	.....
Spiroloculina sp. indet.	.....	.....	Occasional	.....	.....
Seeds of *Chara* (Calcareous alga)	Occasional	.....	Rare	.....	.....

abundance at the outcrop and also in the Sabine Uplift section of northwestern Louisiana. It is to be noted that the foraminifera occur sparingly and those indicated are all members of the Family Miliolidae. A few of these have been identified generically but it has been impossible in this present paper to specifically describe or figure them. It is thought that at least some of these forams will prove good markers, after a more detailed study and a greater abundance of material is available.

The seeds of *Chara* (a calcareous alga) found in the De Queen formation of Arkansas, as noted on the micro-faunal list, are also reported from the Glen Rose of northern Texas[1] and from rocks of corresponding age (Purbeck–Wealden) in England.[2] These fruits are found in many rocks of various geologic ages, so, their value as horizon-markers is greatly lessened from that reason.

The ostracoda are represented in the Trinity micro-fauna by a relatively large number of genera and species and by an abundance of individuals. The ostracods as a class apparently have been able to thrive very well under conditions decidedly unfavorable for the existence of many forms of life. Since conditions during the Trinity epoch were in all probability unsuited for many of the minute and delicate organisms, perhaps that accounts for the paucity of the foraminifera.

Bairdia dorsoventrus n. sp., *Bythocypris rotundus* n. sp., *Cytheridea trinitiensis* n. sp., and *Paracypris weatherfordensis* n. sp., are some of the more characteristic ostracods of the Glen Rose-De Queen formations. These are all new forms and together with other new species and varieties are here described and figured in Plates 13 and 14.

PHYLUM ARTHROPODA—CLASS CRUSTACEA

Sub-Class OSTRACODA

Family BAIRDIIDAE Ulrich and Bassler

Genus BAIRDIA McCoy

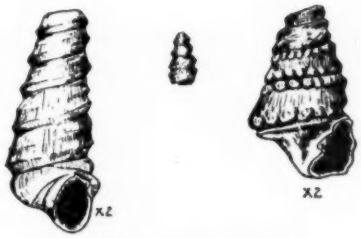
BAIRDIA DORSOVENTRUS, n. sp.
Plate 13, figs. 3, 4

Carapace sub-triangular in outline; height over two-thirds of length, greatest height distinctly anterior to middle; greatest thick-

[1] Winton, W. M., "Geology of Denton County, Texas", Univ. of Texas Bull. No. 2544, p. 64 (1925).
[2] Jones, Rupeet T., "On the Ostracoda of the Purbeck, with notes on those of the Wealden", Quart. Jour. Geol. Soc. vol. XLI, p. 337 (1885).

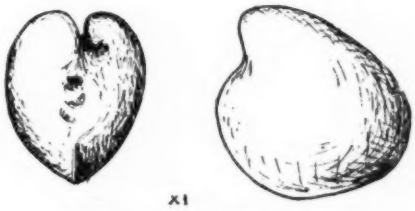
OSTREA FRANKLINI (COQUAND)

OSTREA SUBSPATULA (FORBES)



GLAUCONIA BRANNERI (HILL)

LUNATIA PEDERNALIS (HILL)



CYPRINA MEDIALIS (CONRAD)

TYPICAL MEGASCOPIC FOSSILS OF THE TRINITY GROUP

ness posteriorly. Dorsal margin strongly and evenly arched, more steeply sloping posteriorly; ventral margin only slightly convex. Anterior end broadly and evenly rounded; posterior end sub-obtusely angled. Left valve the larger and overlapping the right only slightly along anterior and posterior margins but very strongly along the postero-central portions of the dorsal and ventral margins. Length, 0.95 mm.; height, 0.62 mm. Holotype No. 501 in Micro-Paleontological Collection of University of Oklahoma. Loc. about 8 miles west of Weatherford, Parker County, Texas.

This species is characterized by the peculiar dorso-ventral overlap, relative great height and sub-obtuse posterior end.

Bairdia dorsoventrus occurs commonly in both the Glen Rose and De Queen formations of the Trinity group.

BAIRDIA GLENROSENSIS, n. sp.

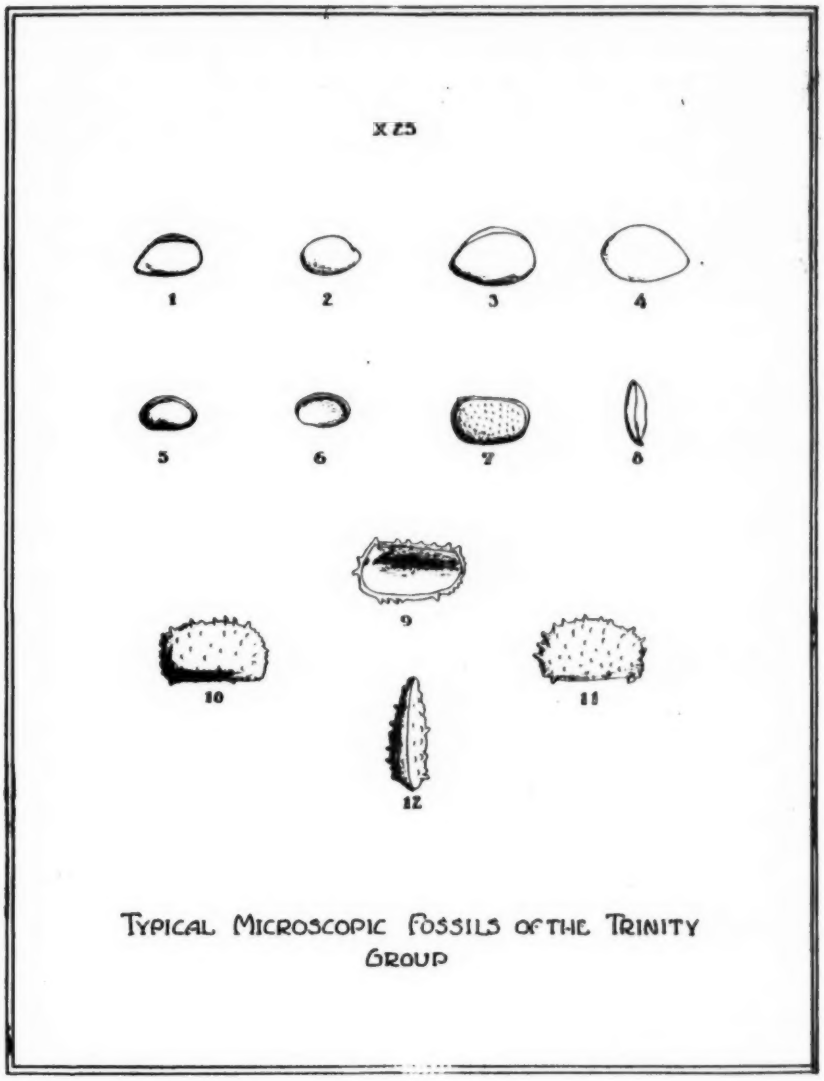
Plate 13, figs. 1, 2

Carapace sub-triangular in side view; height almost two-thirds of length, greatest height at about the middle; greatest thickness posteriorly. Dorsal margin strongly and evenly arched, sloping steeply posteriorly; ventral margin gently convex. Anterior end broadly and evenly rounded; posterior end sub-acute. Left valve larger and overlapping the right all around, especially strongly along the middle portion of the dorsal margin. Length, 0.63 mm.; height, 0.37 mm. Holotype No. 502 in Micro-Paleontological Collection of University of Oklahoma. Loc. about 8 miles west of Weatherford, Parker County, Texas.

This species is easily differentiated by the small size, the peculiar mid-dorsal overlap and the sub-acute posterior end.

EXPLANATION OF PLATE 13

FIG. 1.—*Bairdia glenrosensis*, n. sp. Right valve.
2.—*Bairdia glenrosensis*, n. sp. Left valve.
3.—*Bairdia dorsoventrus*, n. sp. Right valve.
4.—*Bairdia dorsoventrus*, n. sp. Left valve.
5.—*Bythocypris rotundus*, n. sp. Right valve.
6.—*Bythocypris rotundus*, n. sp. Interior view, right valve.
7.—*Cypridea diminutus*, n. sp. Right valve.
8.—*Cypridea diminutus*, n sp. Posterior view.
9.—*Cypridea tuberculata* Sowerby, var. *gypsumensis*, n. var. Interior, left valve.
10.—*Cypridea tuberculata*, var. *gypsumensis*. Right valve.
11.—*Cypridea tuberculata*, var. *gypsumensis*. Left valve.
12.—*Cypridea tuberculata*, var. *gypsumensis*. Posterior view.



TYPICAL MICROSCOPIC FOSSILS OF THE TRINITY GROUP

Bairdia glenrosensis is common in the Glen Rose clays of northern Texas and occurs rarely in the De Queen formation in southwestern Arkansas.

Genus BYTHOCYPRIS Brady

BYTHOCYPRIS ROTUNDUS, n. sp.

Plate 13, figs. 5, 6

Carapace sub-ovate in side view; greatest height and thickness in middle. Dorsal margin obliquely arched; ventral margin nearly straight, ventral border of right valve being slightly incurved near the middle, border of left valve slightly convex. Anterior end bluntly and evenly rounded; posterior end slightly more broadly rounded. Valves strongly convex, the left larger than the right and overlapping all around, especially along the dorsal and ventral margins. Surface smooth. Length, 0.60 mm.; height, 0.32 mm., thickness, 0.30 mm. Holotype No. 503 in Micro-Paleontological Collection of University of Oklahoma. Loc. about 8 miles west of Weatherford, Parker County, Texas.

This form is characterized by the small rotund size, the height and thickness being nearly equal, and the sinuate, uneven ventral margin.

Bythocypris rotundus occurs abundantly in both the De Queen and Glen Rose formations.

Genus PONTOCYPRIS Sars

PONTOCYPRIS PERFORATA, n. sp.

Plate 14, figs. 9, 10

Carapace sub-ovate in side view; greatest height anteriorly; greatest thickness in anterior third. Dorsal margin obliquely convex; ventral margin nearly straight. Anterior end broadly rounded; posterior end tapering to a rounded point. Left valve larger, slightly overlapping the right all around; hinge simple; contact margins broadly beveled; surface coarsely perforate and with a single ventro-posterior spine on the right valve. Length, 0.83 mm.; height, 0.47 mm.; thickness, 0.37 mm. Holotype No. 510 in Micro-Paleontological Collection of University of Oklahoma. Loc. about 8 miles west of Weatherford, Parker County, Texas.

Pontocypris perforata may be distinguished by the coarse surface perforations and ventro-posterior spine on right valve.

This species occurs commonly in the Glen Rose formation and rarely in the De Queen formation.

Family CYPRIDAE Zenker

Genus CYPRIDEA Bosquet

CYPRIDEA DIMINUTUS, n. sp.

Plate 13, figs. 7, 8

Carapace sub-oblong in side view; greatest height in front; greatest thickness in posterior portion. Dorsal margin and ventral margin sub-parallel. Anterior end broadly rounded; posterior end gently convex in middle and angularly rounded in dorsal and ventral portions. Valves flattened and only gently convex, the left valve larger and overlapping the right; with short antero-ventral beak, usually nearly obscure; surface punctate. Length, 0.71 mm.; height, 0.45 mm.; thickness, 0.25 mm. Holotype No. 504 in Micro-Paleontological Collection of University of Oklahoma. Loc. Gypsum Bluff, near Murfeesboro, Pike County, Arkansas.

This form is characterized by its small size, compared with other species of *Cypridea*. The complete absence of spines or tubercles on the surfaces should also be noted.

Cypridea diminutus occurs rather commonly in the De Queen and Glen Rose formations.

CYPRIDEA TUBERCULATA Sowerby, var. GYPSUMENSIS, n. var.

Plate 13, figs. 9, 10, 11, 12

Carapace sub-oblong in side view; slightly broader and more bluntly rounded anteriorly than posteriorly; greatest thickness posterior to middle. Dorsal and ventral margins sub-parallel. Valves strongly convex, left valve slightly larger and overlapping the right; edge view is long-ovate; end view is short-ovate; short antero-ventral beak, often nearly obscured. Surface coarsely punctate and with numerous large, scattered spines, variable in size and position. Length, 1.05 mm.; height, 0.62 mm.; thickness, 0.61 mm. Holotype No. 606 in Micro-Paleontological Collection of University of Oklahoma.

The variety *gypsumensis* differs from the typical form in being larger, beak and notch less prominent, tubercles coarse and longer, and the contact margins unfurrowed.

This variety of *C. tuberculata* has been found in only one locality, the upper De Queen clays at Gypsum Bluff, near Murfreesboro, Pike county, Arkansas.

CYPRIDEA VENTROSA Jones, var. BISPINOSUS, n. var.

Plate 14, figs. 1, 2

Carapace ob-ovate in side view; greatest height anteriorly; greatest thickness posterior to middle. Dorsal margin convex, protruding slightly anteriorly; ventral region concave, borders incurved obliquely forming a broad flat base; antero-ventral notch and beak broad and well defined. Left valve overlaps the right, especially along ventral margin; edge view of carapace sub-ovate. Surface finely punctate, with many small spines and two typical coarse long spines, standing out prominently on the posterior portion of each valve. Length, 1.03 mm.; height, 0.66 mm.; thickness, 0.48 mm. Holotype 506 in Micro-Paleontological Collection of University of Oklahoma. Loc. Gypsum Bluff, near Murfreesboro, Pike County, Arkansas.

The variety of *bispinosus* differs from the typical form in being higher and thicker, the greatest height being posteriorly rather than anteriorly, the absence of ridges marking the ventral region and the two long thick posterior spines standing out prominently among the numerous smaller short tubercles.

This variety of *C. ventrosa* occurs commonly in the DeQueen formation in Arkansas and rarely in the Glen Rose in Texas.

Genus PARACYPRIS Sars

PARACYPRIS WEATHERFORDENSIS, n. sp.

Plate 14, figs. 11, 12

Carapace elongate, narrow; height less than one-half of length; greatest height and thickness in anterior third. Dorsal margin con-

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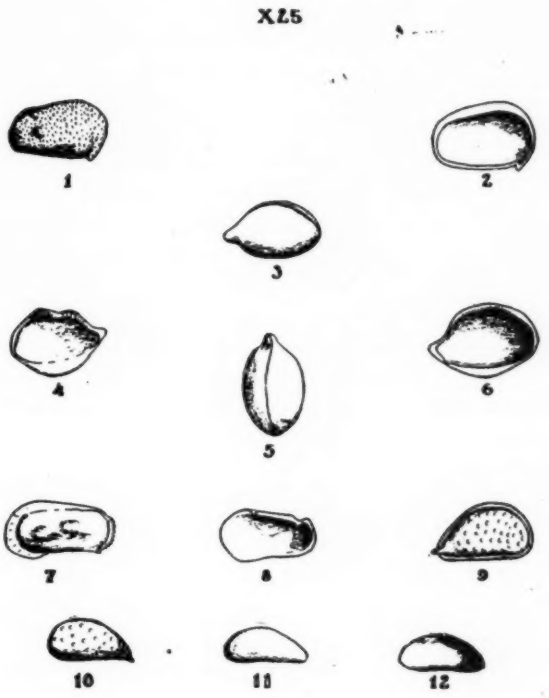
EXPLANATION OF PLATE 14

FIG. 1.—*Cypridea ventrosa* Jones, var. *bispinosus*, n. var. Right valve.
2.—*Cypridea ventrosa* Jones, var. *bispinosus*, n. var. Left valve.
3.—*Cytheridea trinitiensis*, n. sp. Right valve.
4.—*Cytheridea trinitiensis*, n. sp. Interior of right valve.
5.—*Cytheridea trinitiensis*, n. sp. Dorsal view.
6.—*Cytheridea trinitiensis*, n. sp. Interior of left valve.
7.—*Cythere ornata*, n. sp. Left valve.
8.—*Cythere ornata*, n. sp. Interior of right valve.
9.—*Pontocypris perforata*, n. sp. Right valve.
10.—*Pontocypris perforata*, n. sp. Left valve.
11.—*Paracypris weatherfordensis*, n. sp. Left valve.
12.—*Paracypris weatherfordensis*, n. sp. Interior, right valve.



TYPICAL MICROSCOPIC FOSSILS OF THE TRINITY GROUP.

vex; ventral border nearly straight, sometimes slightly concave. Anterior end bluntly rounded; posterior end tapering obliquely to an acute rounded point. Left valve the larger, overlapping the right all around; surface smooth. Length, 0.80 mm.; height, 0.32 mm.; thickness, 0.29 mm. Holotype No. 509 in Micro-Paleontological Collection of University of Oklahoma.

Paracypris weatherfordensis occurs very abundantly in certain clay beds in the Glen Rose formation at the outcrop near Weatherford, Parker county, Texas. It occurs less abundantly in the De Queen formation in Arkansas.

Family CYTHERIDAE Zenker

Genus CYTHERIDEA Bosquet

CYTHERIDEA TRINITIENSIS, n. sp.

Plate 14, figs. 3, 4, 5, 6

Carapace sub-rhomboidal to sub-triangular in side view; height about two-thirds of length, greatest height in middle; greatest thickness posteriorly. Dorsal margin strongly yet unevenly arched; ventral margin gently convex, ventral region as a whole inflated, flat to concave, and extended posteriorly to form a distinct obtuse beak. Anterior end broadly rounded. Valves nearly equal, the left slightly overlapping the right, especially along the dorsal border. Hinge formed by two crenulated crests on the right valve which articulate with corresponding depressions or sockets on the left valve. Surface smooth or bifurcately rugose.

Holotype. 507 in Micro-Paleontological Collection of University of Oklahoma. Loc. 8 miles west of Weatherford, Texas.

This form is easily recognized by the shape, well pronounced posterior beak, peculiar hingement, and the rugose surface markings.

Cytheridea trinitiensis occurs in greater abundance in the Glen Rose and De Queen formations than any other micro-form. It is thought to be restricted to and typical of Trinity rocks.

Genus CYTHERE Müller

CYTHERE ORNATA, n. sp.

Plate 14, figs. 7, 8

Carapace oblong-ovate in side view; greatest height anteriorly; greatest thickness near middle. Dorsal margin straight; ventral margin nearly straight, often slightly concave. Anterior end broadly

rounded; posterior margin angularly curved. Valves nearly equal, right valve slightly larger and overlapping. Hinge of right valve with strong teeth, one at each end of a horizontal bar, left valve with corresponding groove and sockets. Surface reticulate; anterior marginal rim crenulated and extending backward into an oblique, granulated ventral ridge which stops abruptly in the mid-posterior region forming a prominent lobe; a restricted dorsal ridge forms a similar lobe; between the two lobes is a sub-central round large node; the posterior rim is crenate, the ventral edge dentate. Length, 0.85 mm.; height, 0.46 mm.; thickness (including nodes), 0.42 mm. Holotype No. 508 in Micro-Paleontological Collection of University of Oklahoma. Loc. Gypsum Bluff, near Murfreesboro, Pike County, Arkansas.

This species of *Cythere* is distinguished by the peculiar ornate surface markings and features. It occurs sparingly in both the De Queen and Glen Rose formations.

AMMONITES OF THE GENUS DIPOLOCERAS, AND A NEW HAMITES FROM THE TEXAS CRETACEOUS[1]

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ABSTRACT

Five species of the genus *Dipoloceras* and one *Hamites* from the north Texas Fredericksburg are made known. Two of the species of *Dipoloceras* are referred to species already described from Europe, and their stratigraphic levels are correlated with well known zones there. The hamitid and two species of *Dipoloceras* are new. One fragment belonging to *Dipoloceras* is not determinable.

Geologists interested in the paleontology of the Texas Fredericksburg have often been puzzled by the fact that these beds, while rich in thin bodied slightly ornamented ammonites belonging to such genera as *Engonoceras*, and *Oxytropideceras*, have rarely if ever, yielded any of the other types of ammonoids so abundantly characteristic of the Lower and Middle Albian of other parts of the globe. The recent discovery, in the Fredericksburg of North Texas, of specimens belonging to the genera *Dipoloceras* (a genus common to the Albian of the Mediterranean province almost everywhere) and *Hamites* will therefore be of interest to workers in Albian stratigraphy and paleontology.[2] The species of *Dipoloceras* are also interesting, in this particular case, because they establish with reasonable certainty, the presence in Texas of at least two of Spath's zones of the Gault at Folkstone[3] (namely, the zones of *Dipoloceras cornutum* and *D.*

[1] I am grateful to Drs. John B. Reedside, Jr., and T. W. Stanton, of the United States National Museum, for valuable criticism and suggestions in the preparation of this paper.

[2] Spath, L. F., "On Cretaceous Cephalopoda from Zululand", Ann. S. African Museum, vol. XII, pt. 7, 1921, p. 280, under his description of Dipoloceras sp. nov., includes Schloenbachia n. sp. Bose, but apparently with doubt. I am not convinced that this assimilation is justified. These American forms, similar to the one described by Bose, certainly differ widely from the typical Dipoloceras.

[3] Spath, L. F., "A monograph of the Ammonoidea of the Gault", Paleontographical Soc., pt. 1, 1923, p. 4 and "On the Zones of the Cenomanian and Uppermost Albian", Proceed. Geol. Assoc., vol. XXXVII, 1926, p. 421. Although Spath, in the latter publication, has dropped D. cornutum as a zoning fossil, due to its rarity and considerable range, it is retained here until more satisfactory zoning material may be found in Texas.

cristatum), and add materially to the considerable number of ammonite zones already known to exist in common with the Cretaceous rocks of America and of other parts of the world.

The genus *Dipoloceras* is represented in my collection by eight specimens aggregating at least five species, possibly more; but the scarcity of individuals and the state of preservation of some prevent my making separate species out of these which further collecting may prove to be only varieties.

One of my fossils I consider a badly corroded *Dipoloceras* sp. aff. *D. cornutum* (Pictet); another closely related individual is, I believe, a new species of the same group; three are varieties of *D. cristatum* (Deluc); two excellent specimens are close to *D. quadratum* Spath, but since certain differences prevail between that species and my fossils I am creating a new species. The remaining individual, a miserable fragment, is too poor for specific determination, but can without fear of serious error be assigned to *Dipoloceras*.

Hamites is represented by a single poorly preserved fragment of doubtful affinities, but due to definite characters which separate it from any of the known hamitids, I am giving it a specific name.

This list of fossils ought to be augmented by further collecting before final analysis of the species is undertaken. However, since the hitherto unknown presence, in this section of the world, of the forms in question is of unusual interest, and especially since representatives are so rare in Texas as to make the finding of any other specimens largely accidental, it is deemed wise to record the existing ones now. When other material comes in, as it probably will, revision of this note can be made.

Before these fossils came to light in Texas, I[4] had discussed their absence and attributed it to the widespread neritic and zoogene facies of the sea in which the Fredericksburg rocks were deposited, rather than to barriers which might have completely isolated the Texas region, thus preventing the invasion of typical ammonoid faunas. The finding of the few specimens here considered would seem to be, at least, not damaging to such an idea.

[4] Scott, Gayle, "Etudes stratigraphiques et paleontologiques sur les terrains cretaces du Texas", These, Grenoble; also, Ann. Univ. Grenoble, Sect. Sci.-Med. 3 (1), 1926, pp. 57, 163.

DESCRIPTION OF SPECIES

Genus DIPOLOCERAS Hyatt

DIPOLOCERAS sp. aff. D. CORNUTUM (Pictet)

Plate 16, figs. 11, 12

Ammonites cornutus PICTET, in PICTET & ROUX, Mém. Soc. Phys. Hist. Nat. de Genève, t. XI, 1847, p. 93, pl. VIII, figs. 6a, b, c.

Mortoniceras? cornutum CH. JACOB, Thèse, Paris; also, Trav. Lab. Univ. Grenoble, vol. VIII, 1907, pp. 326, 384.

Inflaticeras cornutum STIELER, N. Jahrbuch, Min. Geol, u. Pal., Beilage-Band XLVII, 1922, p. 309, text figs. 2, 3.

Dipoloceras cornutum SPATH, Ann. S. African Museum, vol. XII, pt. 7, 1921, p. 278.

A single poorly preserved specimen from the Norman E. Nelson collection at Texas Christian University is, I believe, a representative of this species, but due to corrosion, certain characters have been destroyed; hence I hesitate to assign it irrevocably to that species.

The fragment consists of a whorl section about 50 mm. long, feebly embracing a corresponding section from the next inner whorl. This inner section is, however, so crystallized that it is difficult to make out its characters. After grinding away a considerable portion of one end and polishing the surface I have been able to make out a slightly displaced outline similar to the whorl cross-section given by Stieler. (See text figure A2).

The outer whorl when viewed in section presents a hexagonal outline, but with the side representing the venter deeply sulcated and devoid of a keel, that structure having been removed by erosion. The angles at the sides of the whorl are due to tubercles placed at the points of bifurcation of some of the secondary ribs. The umbilicus is deep, and the whorls are only slightly embracing.

The fragment has three kinds of ribs; (1) large heavily knobbed and tuberculated ones of unusual prominence, on which the tubercles point ventrally and to a slight degree laterally; (2) less prominent ribs which bifurcate at tubercles near the middle of the sides of the whorl; and (3) simple, non-tuberculated, slightly flexuous ribs. Near the anterior end the specimen has two of the primary ribs with a single simple rib intercalated between them. Behind the second

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EXPLANATION OF PLATE 15

FIGS. 1–4.—*Dipoloceras fredericksburgense* Scott, n. sp.

1.

2.

3.

4.

primary rib are a simple rib joined to the primary, a simple one entire, and two secondary or bifurcate ones. Here a simple tertiary rib is apparently joined to a primary, in front of which the specimen is broken off.

In certain particulars, this ribbing departs from the typical as figured by Pictet. His figures show a form with straight, simple costation, well spaced; whereas in my fossil the ribs are slightly flexuous, often bifurcate, and considerably more closely spaced. His figures (and his description seems to correspond to the figures) show the large knobs to be due to the abnormal development of certain individual ribs. In the Texas fossil small tertiary ribs may be fused to the larger tuberculated ones. These differences have confused me not a little, especially since the figure given by Stieler shows an individual with ribs slightly flexuous, and often bifurcate; and some of the knobs would seem to involve more than a single rib. At the same time, Ch. Jacob specifically states that the enormous knobs are due to the fusion of the ribs. With all of these papers before me, I have not felt justified in making a new species of the Texas fossil.

The fragment is septate throughout and I have outlined the suture, but the surface of the specimen is so worn that the delineation is poor and shows a suture very unsatisfactory for comparison.

Locality.—The specimen here described and figured was collected at the Goodland locality, one mile northwest of Benbrook, Tarrant County, where practically the entire thickness of the Goodland is exposed. From the matrix it is clear that it came from the yellow clay members near the base. So far as I know, no other representative of this species has been listed from the Western Hemisphere.

Spath[5] reports *Dipoloceras cornutum* from his zones V, VI, VII, and VIII in the Gault at Folkstone.

DIPOLOCERAS TARRANTENSE, n. sp.

Plate 16, figs. 1, 2

Measurements

Diameter	30 mm.
Umbilicus	9 mm.
Height of last whorl	10 mm.
Thickness of last whorl	12 mm.

My collection contains a single individual, which although closely related to *Dipoloceras cornutum,* is sufficiently different to be given

[5] Spath, L. F., "Ammonoidea of the Gault", Loc. Cit., p. 4; and "Zones of the Cenomanian and Uppermost Albian", Loc. Cit., p. 421.

a new specific name. It differs from that well known species, and from the individual just described, by its whorl section more depressed and more quadrate in outline; by its bifurcate and more flexuous ribs which split nearer the umbilicus than in the form referred to *D. cornutum;* and by the constitution and attitude of the large knobs. These often involve several ribs, and instead of being directed ventrally as in *D. cornutum,* they point laterally, while their

Fig. A. Diagram showing cross-section, and attitude of knobs of *Dipoloceras cornutum* and *D. tarrantense:* 1, from *D. cornutum* as figured by Pictet; 2, same species as figured by Stieler; 3, cross-section of *D. tarrantense* n. sp.

base often cuts diagonally across the ribs. (See text figure A1, 2, & 3). My specimen has several of these knobs; one is almost as wide as the whorl thickness and involves five ribs.

The specimen is septate throughout and the suture does not noticeably depart from that of *D. cornutum* as figured by Pictet.

As already noted, Spath[6] has reported a considerable stratigraphic range for *D. cornutum.* Due to its wide range, and also to the fact that the fossil, even in Europe, is rare, he has substituted other species as markers of the zones originally designated as the zones of *D. cornutum.* My specimen of *D. tarrantense* was collected at a stratigraphic level considerably above that of the form already referred to *D. cornutum.* It is not impossible that specimens like *D. tarrantense,* or at least closely related ones, may in the past have been referred to *D. cornutum.*

Locality.—The fossil here recorded was collected twenty feet below the top of the Goodland at a locality twenty miles northwest of Fort Worth, and about two miles north of a point where the White Settlement road crosses the Tarrant-Parker County line.

[6] Spath, L. F., "Zones of the Cenomanian and Uppermost Albian", Loc. Cit., p. 421-423.

DIPOLOCERAS CRISTATUM (Deluc), Var.
Plate 16, figs. 3, 4, 5, 8, 9

Ammonites cristatus D'ORBIGNY, Pal. Fr. Terr. Crét., vol. 1, 1842, p. 298, pl. LXXXVIII, figs. 1-5.

Ammonites cristatus PICTET, in PICTET & ROUX, Mém. Soc. Phys. Hist. Nat. de Genève, t. XI, 1847, p. 90, pl. VIII, figs. 2-5.

Mortoniceras? cristatum PERVINQUIÈRE, Mém. Carte Geol. Tunis, Cephalopoda, 1907, p. 239.

Mortoniceras? cristatum CH. JACOB, Thèse; also Trav. Lab. Geol. Univ., Grenoble, vol. VIII, 1907, pp. 326, 384.

Dipoloceras cristatum SPATH, Ann. S. African Museum, vol. XII, p. 7, 1921, p. 277, pl. XXV, fig. 2, pl. XXVI, fig. 6.

Dipoloceras cristatum SPATH, Trans. Royal Soc. Edinburg, vol. LIII, pt. 1, 1922, p. 97.

Three of my fossils appear to be close enough to this species to be referable to it, in spite of the fact that they vary in certain respects from the type, and, as to that matter, somewhat from each other. The large fragment (Pl. 16, fig. 5), apparently a part of the living chamber, is more depressed than the specimen figured by d'Orbigny, but corresponds almost exactly to the fragment figured (fig. 4) and described by Pictet. The flared ribs are entirely characteristic. The forward sweep of the ribs near the keel is noticeable, but is less marked than in the fragment described and figured by Spath in his Zululand paper.[7] That author in his "Ammonoidea of the Gault",[8] makes *D. cristatum* his zone VIII at Folkstone.

The fragment represented in Pl. 16, figs. 3 and 4 is well enough illustrated that further discussion may be dispensed with. (Compare with Pl. VIII, fig. 2, Pictet).

The other (Pl. 16, figs. 8 and 9) more complete, but more poorly preserved specimen is referred to this species with some doubt. It is certainly less typical than the ones already described. The whorl section is less quadrate than in *D. cristatum*, the umbilicus larger and the ribs finer. On the other hand, certain ribs are quite conspicuously flared, a diagnostic character of *D. cristatum*. The suture shows no departure from the typical. Further collecting may show it to be advisable to make a separate species of this form.

Locality.—The large fragment (Pl. 16, fig. 5) was collected under a small bridge, where the Pecan Beach road crosses Chara Creek, one mile northwest of Texas Christian University. The only rocks exposed there are the topmost ledges of the Goodland.

[7] Spath apparently reverts to the specific distinction between the true D. cristatum (Deluc), and D. subcristatum (Deluc). I do not know if such a separation is customary. At least I am not able to recognize it in my specimens.

[8] Spath, L. F., Loc. Cit., p. 4.

The individual (Pl. 16, figs. 3 and 4) was found at the top of the Goodland at the locality mentioned for *D. tarrantense*. The other was collected at the top of the same formation northwest of Fort Worth, near the end of the Arlington Heights car line.

DIPOLOCERAS FREDERICKSBURGENSE, n. sp.
Plate 15, figs. 1, 2, 3, 4

Measurements of type

Diameter	83 mm.
Height of last whorl	30 mm.
Thickness of last whorl	27 mm.
Umbilicus	33 mm.

I am not sure that the two ammonites described under this name are representatives of one and the same species. There are certain marked differences between them, but since I have no other material at my command, I am not able to determine whether or not these differences should have specific rank. They may be due to individual variation. This description deals in particular with the specimen figured in Pl. 15, figs. 1 and 2. If further collecting justifies, the other may later be given a new name.

The species in question is very closely related to *D. quadratum* Spath,[9] but can be separated on the basis of the whorls which are less depressed, the umbilicus which is slightly broader, and the ribs which are more prominent and less regular in size. The entire effect of the ribbing approaches more clearly the *cristatum* type than does that of the African form. The quadrate whorls, carinate and sulcate venter, and the absence of umbilical tubercles mentioned by Spath, are all characters common to the Texas fossil. The thin prominent keel is especially well preserved and is a striking feature.

The suture is not well enough preserved to be completely delineated, but is clearly of the *Dipoloceras* type.

The other specimen (Pl. 15, figs. 3 and 4), although referred to this species, deserves special mention. It differs from the form just described in that it has fewer ribs, certain ones of which are flared almost as prominently as in *D. cristatum*. The sulcate areas beside the keel are not so deep. Certain of the ribs, instead of turning forward at the ventro-lateral angle of the whorl and gradually fading away besides the sulcate area, as is always the case in the individual just described, stop short at the ventro-lateral angle in prominent ven-

[9] Spath, L. F., "On Cretaceous Cephalopoda from Zululand", Ann. S. African Museum, vol. XII, pt. 7, 1921, p. 278, pl. XXV, fig. 3 a-c.

trally directed tubercles. (A similar condition for all of the ribs is represented in d'Orbigny's figure of *Ammonites delaruei*).[10] The other ribs are easily comparable to those of the individual taken as the type of the species.

Th inner whorls of this specimen are somewhat crushed, and the septum cannot be studied.

Locality.—The most perfect individual (Pl. 15, figs. 1 and 2), and the type of the species, was found two miles northwest of Texas Christian University at the nine mile dam on the Clear Fork of the Trinity River, in the topmost Goodland. The other was collected in the highest ledges of the Goodland where they are exposed under the bridge at Chara Creek on the Pecan Beach road, one mile northwest of Texas Christian University, Fort Worth.

DIPOLOCERAS, sp. indet.

Plate 16, figs. 6, 7

A single poor specimen in my hands is not specifically identifiable, but is probably a member of this genus. It is totally different from any Goodland Ammonite that I have seen. Its rectangular whorl, its uniformly arcuated, crested and simple ribs are distinctive. One rib, although badly broken is considerably more prominent than the others, and amounts almost to a flare.

Locality.—Goodland locality mentioned for *D. tarrantense.* It is not known from what level in the Goodland it came.

Genus HAMITES Parkinson

HAMITES ADKINSI, n. sp.

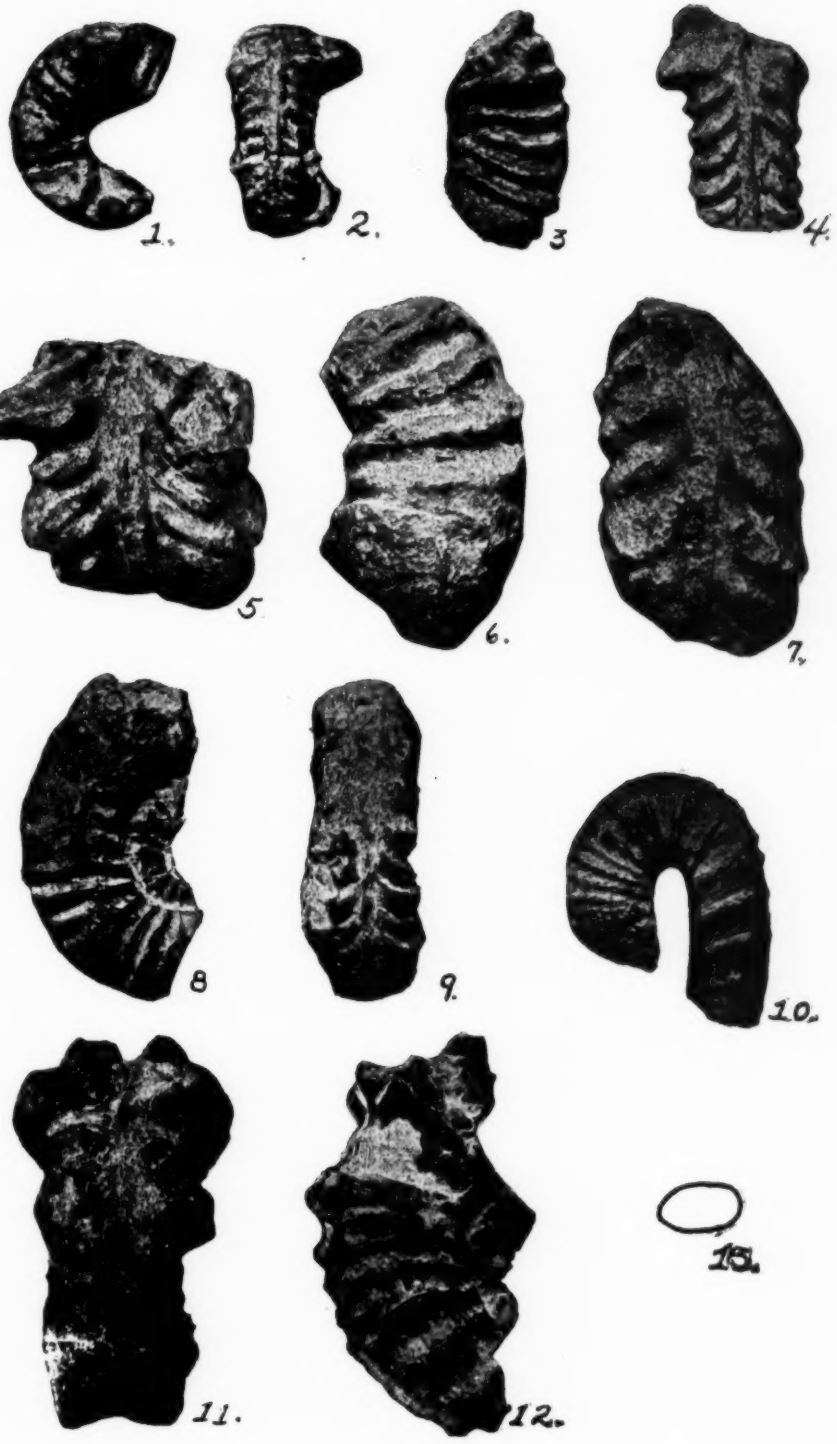
Plate 16, figs. 10, 13

Mr. W. S. Adkins, of the Texas Bureau of Economic Geology, has recently sent me for study a fragment of an uncoiled cephalopod collected from the middle of the Comanche Peak limestone near Valley Mills, Texas. The specimen consists of two almost straight limbs connected by a curve in such a manner as to form a narrow U. The

[10] d'Orbigny, A., "Paleontologie francaise, terrains cretaces", vol. I, pl. LXXXVII, fig. 7.

EXPLANATION OF PLATE 16

FIGS. 1, 2.—*Dipoloceras tarrantense* Scott, n. sp.
3–5, 8, 9.—*Dipoloceras cristatum* (Deluc), var.
6, 7.—*Dipoloceras*, sp. indet.
11, 12.—*Dipoloceras*, sp. aff. *D. cornutum* (Pictet).
10, 13.—*Hamites adkinsi* Scott, n. sp.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limbs are about 32 mm. and 15 mm. long respectively. The short one is larger and is, I believe, the apertural end. The fragment is probably a part of the living chamber since no trace of a suture is anywhere visible. The whorl section is oval, but is more compressed in the short than in the long limb. The characters of the fossil are observable on one side only.

The long limb is ornamented with prominent flange-like ribs interspaced with two to three fine indistinct ribs visible only on the venter. The prominent ones do not cross the dorsum, but become pronounced very near it and, passing ventrally and anteriorly, cross the venter without interruption. Around the curve, the ribbing characteristic of the long limb gradually grades into the uniformly fine ribbed sculpture of the short limb. The faintest indication of tuberculation is visible at the ventro-lateral angle on some of the fine ribs of the short limb, but these may be due to imperfections in the preservation of the fossil. Elsewhere the specimen is absolutely devoid of tubercles.

So far as I am aware, no other hamitid has been listed from the beds of this age in Texas. The form exhibits certain characters which clearly distinguish it from any similar ones of the same age, that I know, in other regions. Therefore, in spite of its fragmentary and poorly preserved state, I feel justified in provisionally assigning it to a genus and in giving it a new specific name.

Everyone knows how difficult fragments of these aberrant Cephalopoda are to determine. This one fits poorly into any of the common genera, but it is nearer to *Hamites* than anything else; even when that genus is taken in the restricted sense given it by Whitehouse.[11] However, it is not impossible to see in the fossil a sort of forerunner of certain forms which are commonly put in the genus *Anisoceras* Pictet. The irregular ribbing of the long limb, and faint suggestion of tubercles on the short limb might indicate such a relationship, but the absence, everywhere, of a distinct bituberculate sculpture excludes it from that genus.

The peculiar ornamentation of this species is sufficient to distinguish it from any of the Albian hamitids that I know. I take pleasure in naming it after Mr. Adkins whose generosity enabled me to study it.

Locality.—The single individual was collected from the middle Comanche Peak at a locality on the Powers Place, near Valley Mills, Texas.

[11] Whitehouse, J. W., "The Cretaceous Ammonoidea of Eastern Australia", Geol. Survey Queensland; Memoirs of the Queensland Museum, vol. VIII, pt. 3, 1926, pp. 224, 230.

THE DEVELOPMENT OF CLIMACAMMINA AND ITS ALLIES IN THE PENNSYLVANIAN OF TEXAS

JOSEPH A. CUSHMAN AND JAMES A. WATERS

ABSTRACT

There are two distinct genera of arenaceous foraminifera which are biserial in the early stages and uniserial in the later ones. Some of these have been referred to *Cribrostomum* Möller but in that genus there are many rounded apertures which appear even in the biserial early stages. Such a condition does not seem to occur in the Texas material. One genus with multiple apertures appearing in the adult in regular sequence is apparently *Climacammina* H. B. Brady. The other with two elliptical apertures in the adult is apparently new. Both genera are represented by two or more species with definite stratigraphic ranges.

There are in the Pennsylvanian of Texas and adjacent regions some large species of arenaceous foraminifera which are biserial in the early stages and uniserial in the adult. These have been heretofore assigned to *Climacammina* and *Cribrostomum*. That this disposition could not be made in all species became evident after we had carefully studied the material.

Climacammina was erected by H. B. Brady in 1876 and *Cribrostomum* by Möller in 1879. The exact characters of Brady's genus should be determined as the first step. The genoholotype is *Climacammina antiqua* H. B. Brady. The generic characters as given by Brady for *Climacammina* are as follows: "Test free, consisting of many segments of irregular contour and unevenly combined; typically biserial or subspiral in the earlier, uniserial in the later stages of growth. Texture finely arenaceous. Interior more or less labyrinthic. Aperture irregular or cribriform. Septation obscure."

The specific characters given for *Climacammina antiqua* are as follows: "Test elongate; subcylindrical, compressed or spathulate, unsymmetrical, sometimes curved at its commencement. Earlier chambers irregularly biserial or subspiral; later ones uniserial, often

set on obliquely. Septation imperfect; sutures marked externally by depressed lines. Segments numerous, more or less ventricose externally; interior subdivided or labyrinthic. Shell-texture compact, firmly arenaceous. Aperture formed of several irregular orifices on the face of the terminal segment."

The various modifications noted by Brady are seen in any large series of Pennsylvanian Climacamminas and are due to crushing and distortion rather than being an essential character of the test. The apertures shown by Brady are not truly circular but elongate and somewhat angled. In the chambers which show casts of the apertures the form is more rounded but it is to be doubted whether or not these are really exact reproductions of the original apertures. The labyrinthic character of the interior is not very definitely marked in Brady's figures and may be due to crushing in of the walls so that in section they appear to be irregularly labyrinthic. None of the very many sections we have examined show signs of a real labyrinthic division of the chambers.

The apertures in these Texas species especially in the early biserial stages have been mistakenly interpreted. It is very easy to mistake darker sand grains for filled apertures and this has undoubtedly been done in some of the species which have been described from Texas as

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EXPLANATION OF PLATE 17.

FIGS. 1–3, 5–8.—*Climacammina cushmani* (Harlton).

1*a*, *b*. *a*, side view; *b*, apertural view. ×20.

2. Apertural view of adult specimen. ×40.

3. Vertical section. ×40.

5. Transverse section showing single-apertured stage. ×30.

6. Transverse section showing three-apertured stage. ×30.

8. Transverse section showing eight-apertured stage. ×30.

7. Oblique view of three-apertured stage. ×30.

4, 9–13.—*Climacammina cylindrica* Cushman and Waters, new species.

4. Exterior of adult. Holotype. *a*, side view; *b*, apertural view. ×30.

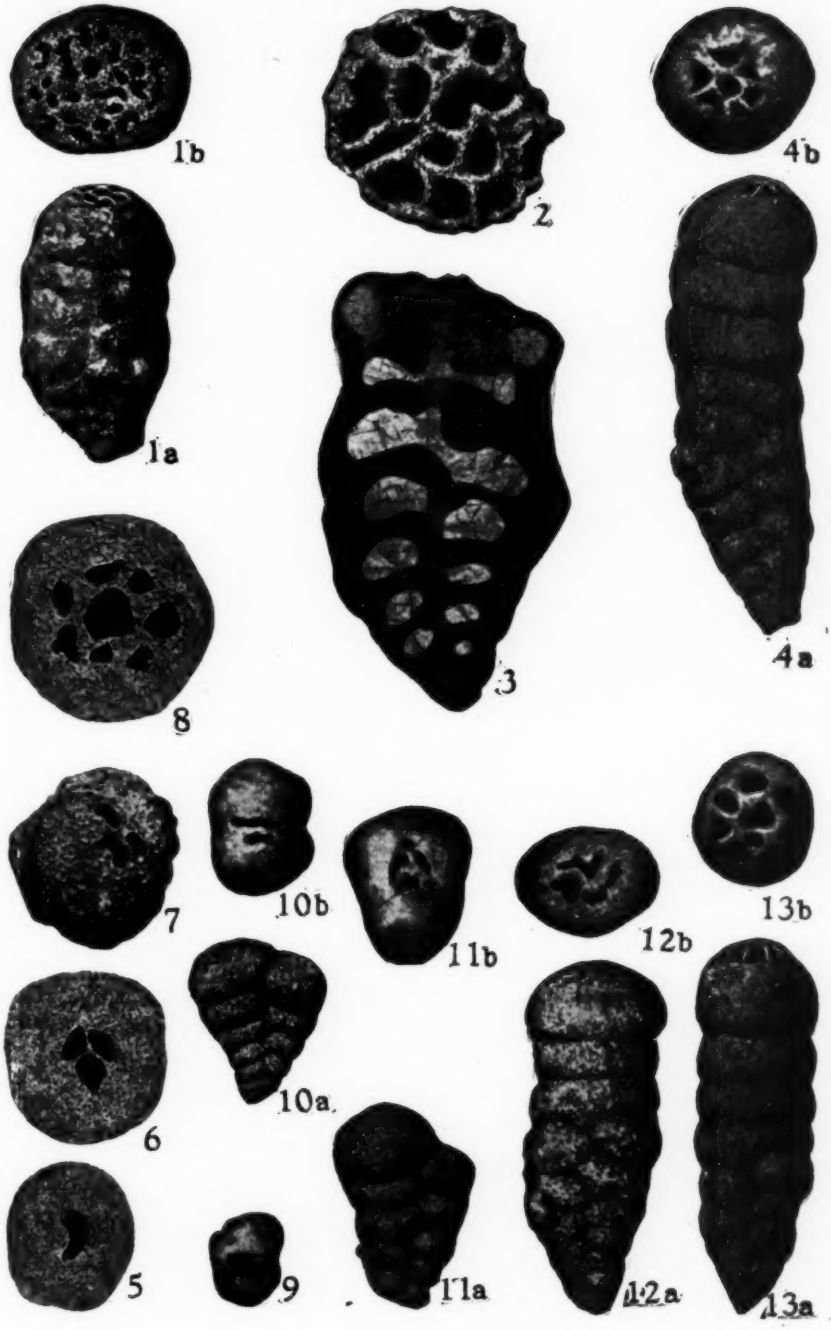
9. Aperture in early stage showing angles. ×30.

10. Exterior of biserial stage. *a*, front view; *b*, apertural view with one aperture entirely cut off. ×30.

11. Exterior of biserial stage. *a*, front view; *b*, apertural view with division into several elongate irregularly shaped openings. ×30.

12. Exterior of partially adult specimen. *a*, front view; *b*, apertural view showing the four-apertured stage. ×30.

13. Exterior of adult. *a*, front view; *b*, apertural view showing the eight-apertured stage. ×30.


1b
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4b
1a
3
4a
8
7
10b
11b
12b
13b
6
10a
5
9
11a
12a
13a

Cribrostomum. We have examined the types in Washington of *"Cribrostomum jeffersonensis, C. lucilleae, C. cushmani,* and *C. attenuata"* of Harlton. These are all described as having multiple rounded apertures and some of them are so figured, but a study of the holotypes does not show such a structure present. It is easy to interpret as apertures some of the darker material of the test.

Those species which may be assigned to *Climacammina* have a very definite development shown in the specimens as Plate 17 and in the idealized upper figures in Plate 20. This in general is as follows: There is an early biserial textularian development with the aperture single, at the inner margin of the terminal face of the chamber (Pl. 17, fig. 9). As shown in the figure this aperture later enters the face of the chamber in an irregular manner, the edges of the opening usually distinctly angular and with lobes extending in from the wall. The single aperture may continue in the uniserial portion moving into a central position (Pl. 17, fig. 5). There may be a definite aperture cut off and later three or four develop as in Plate 17, figs. 10-12. In more typical uniserial chambers there are developed three irregularly triangular chambers (Pl. 17, fig. 6). In later uniserial chambers there is typically developed a seven or eight apertured wall consisting of an irregular, rounded, central opening and a peripheral series of wedge-shaped or triangular openings arranged about it with the pointed ends of the openings toward the central aperture (Pl. 17, figs. 8, 4*b*, 13*b*). In still later adult chambers the number of openings may still further increase and the arrangement becomes irregular (Pl. 17, figs 1*b*, 2). The openings even at this stage are for the most part not regularly rounded. They lose the definite triangular shape and become irregularly lobed or elongate.

All this complexity of the aperture is brought about without any appreciable increase in the size of the apertural face and often with an actual reduction. In the simpler, earlier apertures the openings are confined to the middle of the apertural face while in the more complex apertures they occupy nearly the whole area of the face. The later uniserial chambers are usually much thinner than the earlier textularian ones and this accounts for the more frequent crushing and distortion of the uniserial portion.

Many specimens have been sectioned transversely and the apertures of each chamber drawn as they were exposed in the process. From these the idealized figure shown in Plate 20, figure 1 has been built up showing the aperture as developed in successive stages. As seen in sections, there are apparently two more or less distinct layers of the test, an inner which is of clear calcareous material and perfor-

ate with an outer, opaque layer of arenaceous material. Such a structure is developed in some of the large species of *Textularia* in tropical seas as figured by Moebius.

The genus *Cribrostomum* Möller has several species, the apertural face of which even in the biserial stage has numerous scattered circular apertures of uniform size. The wall in many of the species is apparently calcareous and longitudinally costate. Some of the species seem not to develop beyond the biserial stage. Möller gives *Climacammina* H. B. Brady as a synonym under his *Cribrostomum*. These are not the same, however, as *Climacammina* apparently does not have a series of uniform sized rounded apertures at least in the biserial stage. Whatever may be the characters of the Russian species described by Möller, it seems certain that no species we have seen in the hundreds of specimens from the Pennsylvanian of Texas can be placed under Möller's genus. None of them have numerous rounded apertures of uniform size at any stage and especially not in the biserial stage.

There are however in the Pennsylvanian material from Texas numerous specimens which seem to be generically distinct from *Climacammina* in their apertural characters. They occur occasionally with *Climacammina* but more often alone. The whole later development is very different from that of *Climacammina* and from *Cribrostomum*. The stages of development and sections are shown in Plates 18 and 19. An idealized figure is given in figure 2 of Plate 20.

The early stages are textularian, biserial, with a single elongate aperture on the inner margin of the chamber as is normal in *Textularia*. In the last biserial chambers and the first of the uniserial ones the aperture extends into the face of the chamber forming an elongate, somewhat oblique, rounded opening (Pl. 18, fig. 1). One side of the wall of the aperture extends in as shown in its early stage (Pl. 18, fig. 2) and still later nearly cuts off the inner end of the opening (Pl. 18, fig. 3). This inner portion is finally entirely cut off (Pl. 18, figs. 4, 5). At this stage the apertures are elongate in the axis of the addition of chambers, the ends of the apertures toward the zig-zag suture lines or the broad face of the biserial portion. Later these become twisted (Pl. 18, fig. 6) and in the uniserial chambers (Pl. 18, fig. 7) this is continued further. In the adult the aperture consists of two elliptical openings side by side with a narrow wall between and the axis nearly at right angles to the original axis (Pl. 18, fig. 8). This apertural feature continues throughout the development of the test. In cutting back specimens to obtain the developmental stages, it was found that the middle partition between

the elliptical openings becomes resorbed or broken down, resulting in the form of opening seen in Pl. 18, fig. 9.

This development is very different from that seen in *Climacammina* and forms a distinct genus of which there are several species. The early stages are seen in section in Pl. 18, fig. 12, and sections of the later stages in Plate 19. The details of the structure of the wall with the inner, clear, perforate layer and outer, opaque, arenaceous layer are shown in Pl. 19, fig. 2.

The two genera and their most common species in the Pennsylvanian of Texas are given below.

Genus CLIMACAMMINA H. B. Brady, 1876

Genoholotype *Climacammina antiqua* H. B. BRADY.

Climacammina H. B. BRADY, Pal. Soc. Mon., 30, 1876, p. 67.—CUSHMAN, Special Publ. no. 1, Cushman Lab. Foram. Res., 1928, p. 120.

Test elongate, tapering in the early portion, later portion subcylindrical; chambers numerous, in the early stages biserial, textularian, later uniserial; wall of two distinct layers, an inner, clear, perforate layer and an outer, opaque, arenaceous layer; aperture in the biserial stage usually simple, at the inner margin of the chamber as in *Textularia*, later with a single opening becoming central, followed by a three- or four-apertured stage, then by a seven- or eight-apertured stage, with a central opening surrounded by a series of triangular openings with the angle toward the central opening, and in the final stage often with numerous irregularly lobed or elongate openings in the apertural face of the chamber.

CLIMACAMMINA CUSHMANI (Harlton)

Plate 17, figs. 1-3, 5-8

Cribrostomum cushmani HARLTON, Journ. Pal., vol. 1, 1928, p. 308, pl. 53, figs. 1*a-c*.

Test about twice as long as wide with numerous biserial chambers in the early stages, the breadth rapidly increasing in the last few

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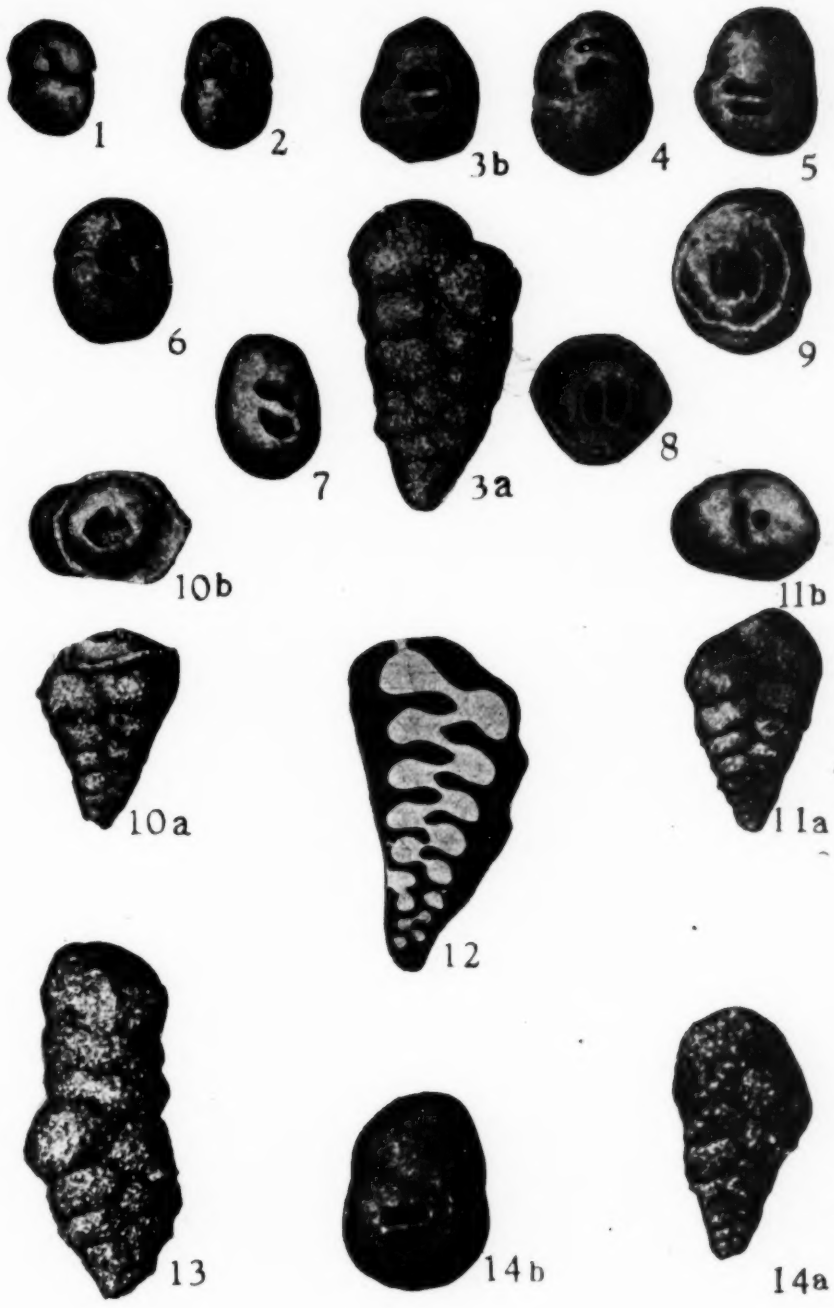
EXPLANATION OF PLATE 18

FIG. *Deckerella laheei* Cushman and Waters, new species.

1–8.—Stages in the development of the apertural characters. ×30.

9.—Aperture showing resorption, the portion between the apertures broken down. ×30.

10–12, 14.—Biserial stages. Fig. 12, Section. ×30. Fig. 13, Adult. Holotype.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3b
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3a
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13
14b
14a

biserial chambers making the sides concave, the adult uniserial chambers few, two to four, usually three, slightly compressed so that in section they are elliptical, periphery broadly rounded; sutures fairly distinct but not deeply depressed; wall with an inner, clear, perforate layer and an outer, opaque, arenaceous layer, the wall of the later uniserial chambers thinner than those of the earlier biserial ones; aperture in the early stages simple, textularian, later with a single aperture in the middle of the face followed by a three-apertured stage, the openings more or less triangular, later a seven-apertured stage, with a central rounded opening surrounded by a series of triangular openings with the apices toward the central opening, and the final stage with numerous irregular openings often lobed and elongate, scattered over the whole outer terminal wall.

Length 2.25 mm.; breadth 1.10 mm.; width 0.90 mm.

The holotype of this species is in the collection of the U. S. National Museum and is from the Millsap formation of the Strawn, found in the Middle Kickapoo Falls limestone, 13 miles South of Weatherford, Parker Co., Texas.

We have examined the holotype which is a young specimen still in the biserial stage and does not show the adult characters. The apertures were originally described as "cribriform, circular, numerous, filled with material and somewhat obscured", but the type figure does not show this character but does have darker spots that might easily be mistaken for filled apertures. We have had abundant specimens of this species from the type locality, and the figures in Plate 17 are from these. Figures 1*b* and 2 are from the terminal faces of adults. Figures 8, 6 and 5 are from a specimen successively cut back in planes at right angles to the elongate axis and show the aperture as it appears in successively younger uniserial chambers. This is a large stout species distinguished in its form and apertures from the following species of the Cisco formation.

EXPLANATION OF PLATE 19

FIGS. 1, 2, 5.—*Deckerella clavata* Cushman and Waters, new species.

1 *a*, *b*. Exterior. Holotype. *a*, front view; *b*, apertural view. ×30.

2. Longitudinal section. ×50.

5. Longitudinal section. ×65.

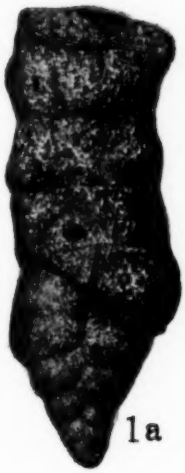
3, 4, 6.—*Deckerella laheei* Cushman and Waters, new species.

3. Exterior. *a*, side view, ×30; *b*, apertural view, ×50.

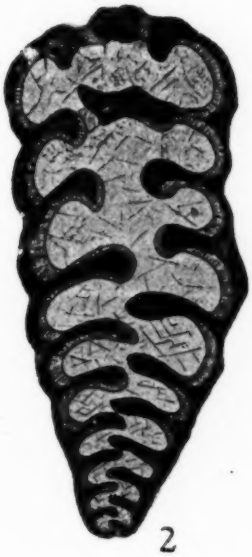
4. Section of megalospheric form. ×50.

6. Section of microspheric form. ×50.

1b



1a



2

3b

3a

4

5

6

CLIMACAMMINA CYLINDRICA Cushman and Waters, new species

Plate 17, figs. 9-13

Test elongate, four or five times as long as wide, subcylindrical, periphery broadly rounded; early chambers in a biserial series, later ones uniserial, usually four in the adult of uniform size, generally circular in section; sutures distinct, deeply depressed especially in the uniserial portion; wall with a clear, perforate, inner layer and an outer, opaque, arenaceous layer; aperture in the earlier stages single, textularian, on the inner margin of the chamber, later with two or four irregularly angular openings, and in the adult with a central opening surrounded by a series of triangular openings, six or seven in number with the apices toward the central opening.

Length 2.0 mm.; breadth 0.60 mm.; thickness 0.60 mm.

Holotype, (Cushman Coll. No. 7542) from the Graham formation of the Cisco, 1 mile West of Graham, Young Co., Texas collected by James A. Waters. The species also occurs in the Graham formation 10 miles N. E. of Breckenridge, on South bend road, Stevens Co., Texas.

This species may be distinguished from the preceding by the more elongate, subcylindrical test and the more regular aperture in the final adult stage.

Genus DECKERELLA Cushman and Waters, new genus

Genoholotype *Deckerella clavata* CUSHMAN and WATERS, new species.

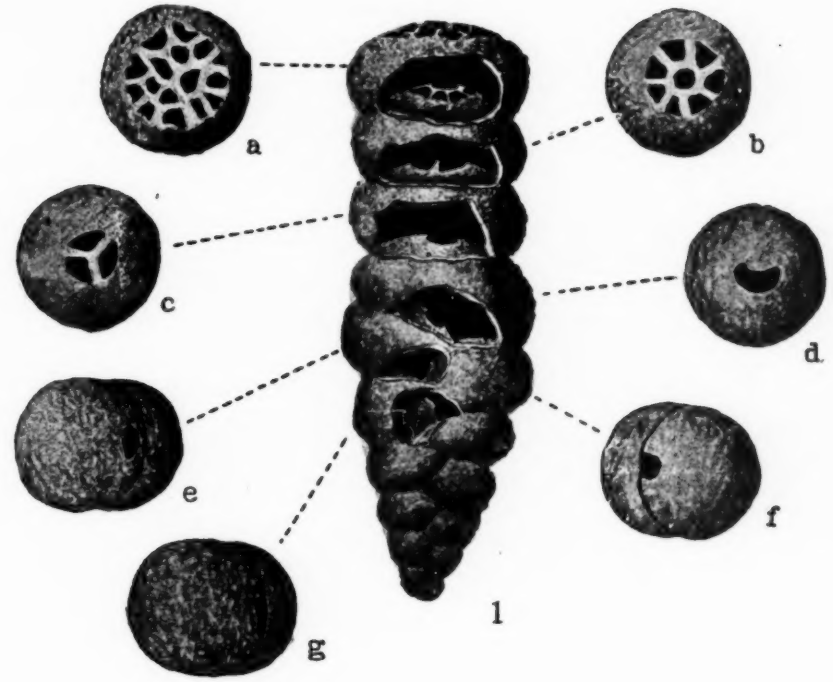
Test elongate, the early stages biserial, textularian, later chambers uniserial; wall with an inner, clear, perforate layer, and an outer, opaque, arenaceous layer; aperture in the early biserial chambers simple, textularian, at the inner edge of the chamber, later pushing into the apertural face finally cutting off two distinct, elongate, elliptical apertures with a narrow partition between and this character continuing throughout the adult.

This genus is named for Professor Charles E. Decker, head of the Department of Paleontology of the University of Oklahoma.

EXPLANATION OF PLATE 20

FIG. 1.—Idealized figure of *Climacammina* showing side view with chamber walls partially broken away showing interior. *a-g*, apertural views of successive chambers.

2.—Idealized figure of *Deckerella* for comparison with the preceding.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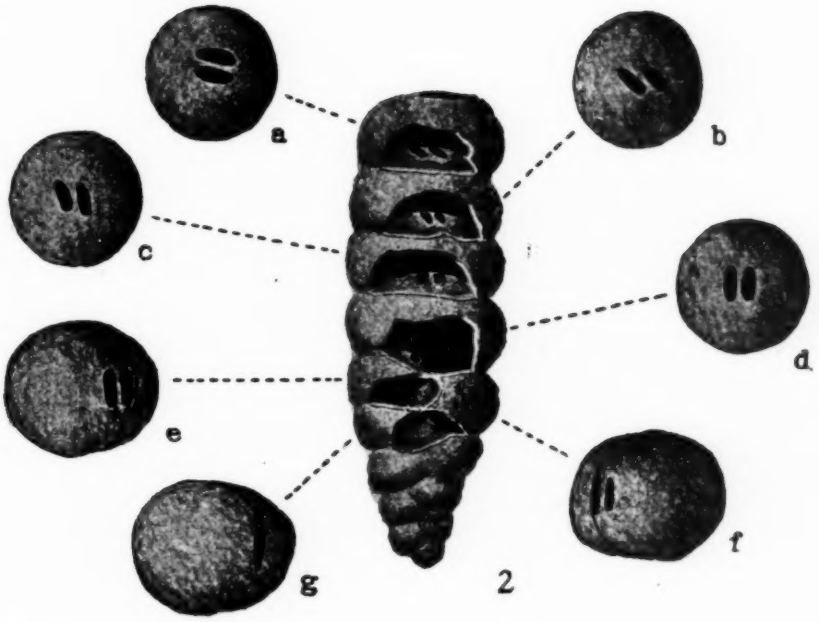
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DECKERELLA CLAVATA Cushman and Waters, new species

Plate 19, figs. 1, 2, 5

Test elongate, about three times as long as broad; early portion biserial, the chambers rapidly increasing in breadth as added, uniserial chambers usually three, nearly circular in section; sutures not strongly depressed; wall with an inner, clear, perforate layer and an outer, opaque, arenaceous layer; apertures in the early biserial chambers simple, textularian, in the uniserial portion with two elongate, elliptical openings with a narrow partition between.

Length 1.85 mm.; breadth 0.70 mm.; thickness 0.55 mm.

Holotype (Cushman Coll. 7589) from Millsap formation of the Strawn, collected from the Kickapoo Falls limestone, 13 miles South of Weatherford, Parker Co., Texas by James A. Waters.

DECKERELLA LAHEEI Cushman and Waters, new species

Plate 18, figs. 1-14; plate 19, figs. 3, 4, 6

Test elongate, slender, cylindrical, early biserial chambers numerous, later uniserial ones up to four or five in the adult, of very uniform size, periphery broadly rounded; sutures distinct, depressed; wall of an inner, clear, perforate layer and an exterior, arenaceous, opaque layer; apertures in the early biserial chambers simple, textularian, in the uniserial portion with two elongate, elliptical openings, with a narrow partition between.

Length up to 2.25 mm.; maximum breadth 0.60 mm.; thickness 0.60 mm.

Holotype (Cushman Coll. 7590) from the Graham formation of the Cisco, 10 miles N. E. of Breckenridge, Stevens Co., Texas, collected by James A. Waters. This is a more slender species than the preceding. A very elongate specimen from five feet above the Gunsight limestone, 1 mile West of Graham, Young Co., Texas is shown in Plate 19, figure 3. Sections are given in Plate 19, figures 4 and 6.

There are apparently other species of both these genera in the Pennsylvanian but they are not as striking in their characters as the ones described here.

FREEZING AND THAWING TO DISINTEGRATE SHALES

By G. D. HANNA AND C. C. CHURCH

Supplementing Mr. H. L. Driver's[1] account of using high pressure cooking to disintegrate refractory shales we wish to call attention to the fact that very satisfactory results can often be had by freezing and thawing. In our experiments we have used samples from wells drilled in Lower Pliocene sediments of the Los Angeles Basin which are exceedingly compact and resistant and such as will not break down by protracted boiling with or without alkalies. The apparatus used was an ordinary household electric refrigerator which would freeze a small sample in one to two hours. The shales were saturated with water and put in a vessel with hardly enough water to cover them. The process is slow but surprisingly effective.

Farmers suitably situated often plow their ground in the fall so as to allow the soil to become mellow through the winter by successive freezing and thawing.

[1] Journ. Paleo., vol. 1, no. 4, 1928, p. 253.

PENNSYLVANIAN OSTRACODS OF OKLAHOMA AND TEXAS

BRUCE H. HARLTON[1]
Amerada Petroleum Corporation, Tulsa

ABSTRACT

The Fossils described below occur very frequently in the Pennsylvanian strata of Oklahoma and Texas. Most of the forms are valuable horizon markers for the formation from which they are described; however, some of the forms described from the Cisco and Graham formations range from Upper to Middle Pennsylvanian.

Family LEPERDITIIDAE Jones (restricted)

Genus PARAPARCHITES Ulrich and Bassler, 1906

PARAPARCHITES WAPANUCKAENSIS Harlton, n. sp.

Plate 21, figs. 1 *a*, *b*

Shell small, obliquely subovate, the longest diameter being from the antero-dorsal to the postero-ventral region at low angle, hinge line straight, cardinal angles moderately sharp. At the swollen antero-cardinal portion of each valve is a pronounced spine. Surface smooth. Length, 1 mm.; height, 0.67 mm.; thickness, 0.4 mm.

Wapanucka limestone, shale near base. Hartshorne Quarry, 2 miles south of Hartshorne, NW ¼ of sec. 18, T. 4 N., R. 17 E., Pittsburg County, Oklahoma. Holotype, U. S. National Museum, No. 72233.

This form is very characteristic of the Wapanucka limestone of Oklahoma. The broad swollen antero-cardinal portion with the spine will readily distinguish this species.

[1] Published by permission of the Amerada Petroleum Corporation. The writer wishes to express appreciation for helpful suggestion and careful criticism to Drs. E. O. Ulrich and R. S. Bassler.

Family BEYRICHIIDAE Jones

Genus HOLLINA Ulrich and Bassler

HOLLINA RADLERAE Harlton, n. sp.
Plate 21, figs. 2 *a*, *b*

Shell large and stout, semi-ovate, slightly convex, with long, straight hinge line and wide concave, strong marginal frill. With the frill the shape of the valves is typically semicircular. Surface exhibits three rounded tubercles, one near the postero-cardinal angle, another little one beneath, and the third very pronounced one near the center of the dorsal margin. A distinct swelling of the surface may be noticed along the ventral margin of the valves. A strong depression of the surface occurs between and extends some distance beneath the largest and smallest of the tubercles. Surface distinctly granulose. Length, 1.29 mm.; height with frill, 0.66 mm.; height without frill, 0.53 mm.; thickness, 0.6 mm.

Belle City limestone. NE ¼ of sec. 8, T. 4 N., R. 6 E., Pontotoc County, Oklahoma. Holotype, U. S. National Museum, No. 72234.

This species resembles *Hollina tricollina* (Ulrich) and differs in the very strong inflation of the shell; the typically semicircular shape, and the very deep depression of the surface between the tubercles. The surface is distinctly granulose.

Family KLOEDENELLIDAE Ulrich and Bassler

Genus JONESINA Ulrich and Bassler

JONESINA OKLAHOMAENSIS Harlton, n. sp.
Plate 21, figs. 3 *a*, *b*

Shell small, semi-ovate, hinge line straight, cardinal angles sharp. It has a deep subcentral sulcus and a small anterior impression with a large rounded node between. The test in the dorsal view is ovate in outline and rounded at the ends. Surface distinctly granulose. Remnants of apparently a marginal frill are visible on the type. Length, 1.10 mm.; height, 0.63 mm.; thickness, 0.5 mm.

Belle City limestone. NE ¼ of sec. 8, T. 4 N., R. 6 E., Pontotoc County, Oklahoma. Holotype, U. S. National Museum, No. 72235.

The very distinct granulated surface and the large rounded node are features easily recognizable.

JONESINA GREGARIA (Ulrich and Bassler)
Plate 21, figs. 4 *a*, *b*

Shell small, subelliptical in outline, the hinge line nearly straight and equaling in length about four-fifths of the longest diameter of the carapace, the cardinal extremities rather obtusely angular, the two ends subequal and rounding regularly into the ventral margin. The latter part of the outline varies in different specimens, being distinctly convex in some and quite straight in the middle third in others. Except the portion of the main vertical sulcus, which is well marked and located a little behind the center of the dorsal half, the surface markings exhibit considerable variation. The sulcus may be narrow with a broad swelling on either side, or it may be wider, the increase being at the expense of the smaller (posterior) swelling. In the former case the posterior lobe is commonly divided medially by a faint vertical sulcus. The large anterior lobe rises abruptly from the median sulcus and is always the most prominent part of the valve. Usually a small spine rises from the antero-dorsal slope, while a faint vertical sulcus is sometimes distinguishable just behind the spine. A large ill-defined, longitudinal swelling generally occupies the lower middle part of the valves, while beneath this more or less obscure depression sets off a ventral marginal flattening or flange. This marginal flange increases in width with age, young examples which then expose the denticulated contact edge of the valve, being without it. Left valve overlapping the right. Length, 1 mm.; height, 0.58 mm.

Upper Glenn formation. SW ¼ of SE ¼ of SE ¼ of sec. 12, T. 6 S., R. 1 E., Love County, Oklahoma, about 7 miles north of Ardmore.

Family KIRKBYIDAE Ulrich and Bassler

Genus AMPHISSITES Girty

AMPHISSITES CISCOENSIS Harlton, n. sp.
Plate 21, figs. 5 *a*, *b*

Shell small, oblong subquadrate in outline, with flattened edges, straight back, cardinal angles sharp. Valves with a prominent, large rounded or subrounded node situated near the middle of the shell. On the dorso-posterior portion is a very pronounced, curved, stout ridge, extending into the marginal ridge and gradually diminishing along the dorso-anterior portion. Surface reticulated. Small narrow pits along the edges of the ridge, also, a very pronounced pit on the posterior side at the central node. Length, 0.7 mm.; height, 0.4 mm.; greatest thickness, 0.4 mm.

Cisco formation. 3 miles east of Moran, below Camp Colorado limestone, on Harperville road, Shackelford County, Texas. Holotype, U. S. National Museum, No. 72237.

The most striking characteristic of this species is the large and stout, curved ridge. The surface is distinctly reticulated.

Genus KIRKBYA Jones

KIRKBYA TEXANA Harlton, n. sp.

Plate 21, figs. 6 *a*, *b*

Shell small, oblate in shape, with thick flattened edges and straight back, cardinal angles moderately sharp, the posterior the less sharp of the two. At the dorso-anterior of each valve is a pronounced ridge, sometimes slightly depressed near the middle, which extends almost over the entire dorsal half of the test and gradually diminishes along the dorso-posterior. Surface coarsely reticulated. Length, 0.55 mm.; height, 0.26 mm.; thickness, 0.22 mm.

Cisco formation. 4½ miles west of Cisco on main Cisco-Abeline road, Eastland County, Texas. Holotype, U. S. National Museum, No. 72238.

Family BAIRDIIDAE Ulrich and Bassler

Genus HEALDIA Roundy

HEALDIA FORMOSA Harlton, n. sp.

Plate 21, figs. 7 *a*, *b*

Shell small, dorsal margin nearly straight in the anterior and posterior halves, rounded near the middle point. Ventral margin straight but curving gradually into the rounded ends. The test in the dorsal view is wedgelike, the anterior end being thin and sharp, the posterior end swollen. On the outward posterior part of each valve are two large spines, and in the dorsal view shows the ventro-posterior spines located farther posteriorly than the dorso-posterior spines. Left valve larger, overlapping the right on all sides. Surface smooth. Length, 1.10 mm.; height, 0.62 mm.; thickness, 0.4 mm.

Gaptank formation,[2] according to Robert and Phillip King. 1½ miles northeast of Wolfcamp, 450 feet below upper Gaptank, Pecos County, Texas. Holotype, U. S. National Museum, No. 72239.

[2] The fossils found at this locality suggest Dimple age and not Gaptank.

This species is distinguished from all other forms by the arrangement of the spines. The ventro-posterior spine is situated farther backwards than the dorso-anterior one, furthermore the spines are usually curved.

HEALDIA MARGINATA Harlton, n. sp.
Plate 21, figs. 8 *a*, *b*

Shell very small, dorsal margin nearly straight in the anterior and posterior halves, rounded to subangular near the middle point. Ventral margin very slightly curved or straight, but curving gradually into the rounded ends. The test viewed from above is wedgelike, anterior moderately sharp, posterior end thick with well developed ridge, which gradually thins toward the dorso-posterior portion. On

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EXPLANATION OF PLATE 21

FIG. 1 *a*, *b*.—*Paraparchites wapanuckaensis* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

2 *a*, *b*.—*Hollina radlerae* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

3 *a*, *b*.—*Jonesina oklahomaensis* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

4 *a*, *b*.—*Jonesina gregaria* (Ulrich and Bassler). *a*, lateral view of left valve; *b*, dorsal view.

5 *a*, *b*.—*Amphissites ciscoensis* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

6 *a*, *b*.—*Kirkbya texana* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

7 *a*, *b*.—*Healdia formosa* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

8 *a*, *b*.—*Healdia marginata* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

9 *a*, *b*.—*Healdia torquata* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

10, *a*, *b*.—*Healdia squamosa* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

11.—*Bairdia grahamensis* Harlton, n. sp., lateral view of left valve.

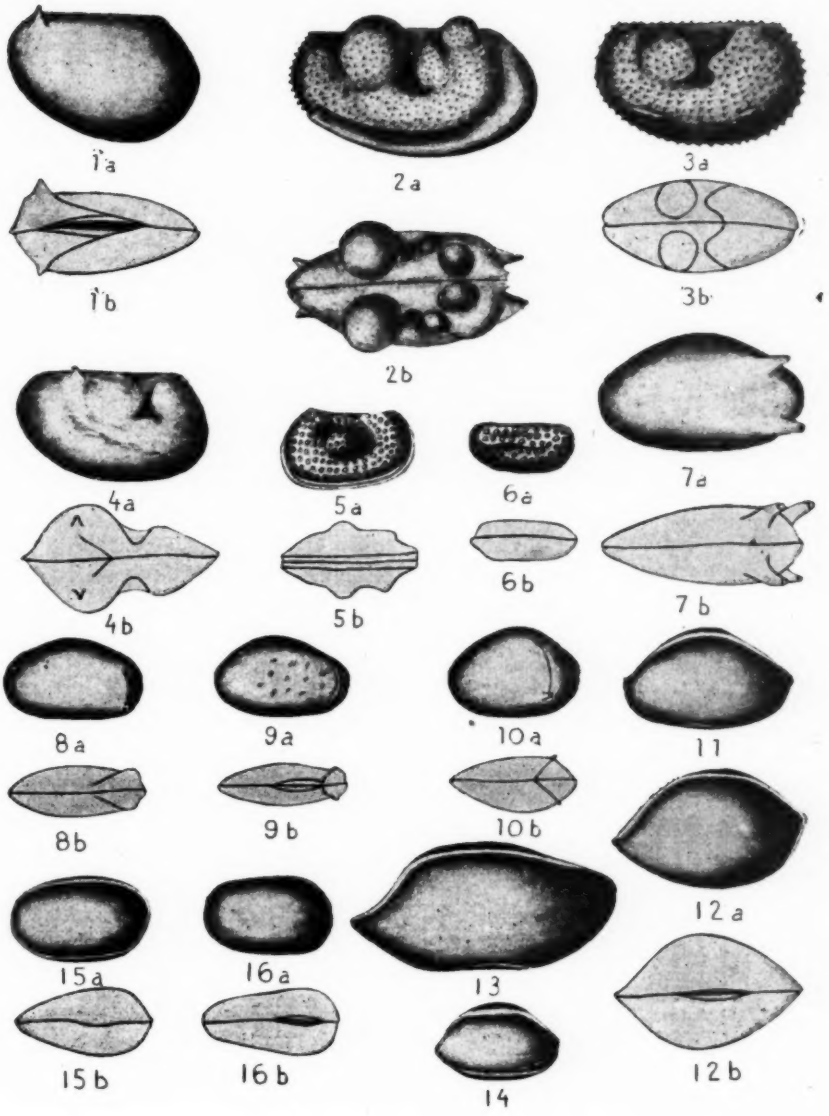
12 *a*, *b*.—*Bairdia nitida* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

13.—*Bairdia pompilioides* Harlton, n. sp., lateral view of left valve.

14.—*Bairdia hispida* Harlton, n. sp., lateral view of left valve.

15 *a*, *b*.—*Cytherella ovoidiformis* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.

16 *a*, *b*.—*Cytherella calcar* Harlton, n. sp. *a*, lateral view of left valve; *b*, dorsal view.


1a
1b
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9a
9b
10a
10b
11
12a
12b
13
14
15a
15b
16a
16b

the outward ventro-posterior portion of each valve is a small spine. Left valve larger, overlapping the right on all sides. Surface smooth. Length, 0.7 mm.; height, 0.4 mm.; thickness, 0.27 mm.

Caney shale, NE ¼ of NE ¼ of NW ¼ of NE ¼ of sec. 12, T. 3 N., R. 2 E., Carter County, Oklahoma. Holotype, U. S. National Museum, No. 72240.

HEALDIA TORQUATA Harlton, n. sp.
Plate 21, figs. 9 *a*, *b*

Shell very small, dorsal margin straight in the anterior and posterior halves and rounded to subangular near the middle point. Ventral margin straight but curving gradually into the rounded ends. The test viewed from above is more or less wedgelike. The dorso-posterior slope is almost straight. On the outward dorso-posterior part of each valve is a very conspicuous curved thick ridge. Left valve larger, overlapping the right on all sides. Surface with several rows of widely spaced punctaé. Length, 0.61 mm.; height, 0.4 mm.; thickness, 0.24 mm.

Graham formation. Wayland shale, south of Gunsight, Stephens County, Texas. Holotype, U. S. National Museum, No. 72241.

HEALDIA SQUAMOSA Harlton, n. sp.
Plate 21, figs. 10 *a*, *b*

Shell very small, dorsal margin curved, anterior half gently curved, posterior half straight and rounded near the middle point. Ventral margin straight but curving gradually into the rounded ends. The test in the dorsal view is wedgelike, the anterior end being rather thin and sharp, posterior end swollen with a rather well developed ridge which gradually thins toward the outward dorso-posterior. On the outward ventro-posterior portion of each valve is a spine. Left valve larger overlapping the right on all sides. Surface smooth. Length, 0.59 mm.; height, 0.46 mm.; thickness, 0.29 mm.

Caney shale, NE ¼ of NE ¼ of NW ¼ of NE ¼ of sec. 13, T. 3 S., R. 2 E., Carter County, Oklahoma. Holotype, U. S. National Museum, No. 72242.

Genus BAIRDIA McCoy

BAIRDIA GRAHAMENSIS Harlton, n. sp.

Plate 21, fig. 11

Shell small, subdeltoid in outline, length usually a little less than twice the height. Overlapping dorsal border of left valve thick, ventral overlap moderately thick near the center. Dorsal border arched, dorso-posterior slope straight, dorso-anterior slope slightly concave with an inconspicuous curve at the extremity. Ventral border straight or very slightly curved. Anterior and posterior extremities acuminate. Valves inequal, hingement formed by the overlap of the left valve over the right. Surface evenly convex, smooth. Length, 0.9 mm.; height, 0.52 mm.; thickness, 0.38 mm.

Graham formation, top of South Bend shale below Gunsight limestone, west of Graham, Young County, Texas. Holotype, U. S. National Museum, No. 72243.

This species resembles *B. curta* McCoy var. *bicornis* J. & K., but in having the posterior slope straight, the very pronounced and strongly curved ventro-extremities, and the straight or slightly curved ventral border.

BAIRDIA NITIDA Harlton, n. sp.

Plate 21, fig. 12

Test small, strongly inflated, subrhomboidal in outline, the greatest thickness being near the middle; overlapping dorsal edge of left valve rather thick and extending into the ventro-posterior half with no ventral overlap to the ventro anterior. Dorsal border elevated and straight or very slightly curved near the middle; dorso-posterior slope straight, dorso-anterior slope slightly concave near the extremity; posterior extremity bluntly acuminate; ventral border curved to the anterior extremity. Valves inequal, hingement formed by the overlap of the left valve over the right. Surface evenly convex, smooth. Length, 1.33 mm.; height, 0.62 mm.; thickness, 0.6 mm.

Hoxbar formation, SW ¼ of SE ¼ of SE ¼ of sec. 12, T. 6 S., R. 1 E., Love County, Oklahoma, about seven miles south of Ardmore. Holotype, U. S. National Museum, No. 72244.

The strong inflation of the shell and the overlap which thins out entirely along the ventro-posterior portion characterize this species.

BAIRDIA POMPILIOIDES Harlton, n. sp.
Plate 21, fig. 13

Shell large, elongately subdeltoid in outline, length about twice the height. Overlapping dorsal border of left valve thick, the ventral overlap moderately strong near the middle. Dorsal border elevated, straight or slightly curved near the middle, dorso-posterior slope slightly concave, dorso-anterior slope with a pronounced conspicuous curve near the middle. Ventral border straight or slightly incurved; anterior extremity rounded, most prominent above, posterior extremity acuminate. Valves inequal, hingement formed by the overlap of the left valve over the right. Length, 1.96 mm.; height, 1.0 mm.; thickness, 0.7 mm.

Hoxbar formation, NW cor. of sec. 20, T. 5 S., R. 1 E., Carter County, Oklahoma, about 2 miles south of Ardmore. Holotype, U. S. National Museum, No. 72245.

This species resembles *B. curta* McCoy var. *bicornis* J & K, but differs considerably in its less excavated anterior and posterior slopes.

BAIRDIA HISPIDA Harlton, n. sp.
Plate 21, fig. 14

Shell thick, subrhomboidal in outline, the point of greatest thickness near the middle, length about 1½ times the height. Overlapping dorsal and ventral border of left valve thick. Dorsal border arched, dorso-posterior gradually curving into a straight slope, dorso-anterior rather abruptly bent into a straight slope to the extremity. Posterior extremity acuminate, arching broadly into the ventral margin; anterior extremity less acuminate than the posterior. Valves inequal, hingement formed by the overlap of the left valve over the right. Surface evenly convex, smooth. Length, 1.26 mm.; height, 0.77 mm.; thickness, 0.67 mm.

Cisco formation, 4½ miles west of Cisco on the main Cisco Abeline road, Eastland County, Texas. Holotype, U. S. National Museum, No. 72246.

The arched dorsal border with its strong overlap and rather abrupt curve near the anterior which bends into a straight slope to the extremity and the inflation near the middle of the shell make this species easily recognizable.

CYTHERELLA OVOIDIFORMIS Harlton, n. sp.
Plate 21, figs. 15 *a*, *b*

Shell suboblong, rounded at the ends; the posterior extremity is most obtuse. The dorsal and ventral borders slightly curved. The shell in the dorsal view is wedgelike, the anterior end being thin and sharp. The pronounced overlap of the left valve by the right is strongest near the middle. Surface evenly convex, smooth. Length, 1.2 mm.; height, 0.73 mm.; thickness, 0.58 mm.

Graham formation, Wayland shale, south of Gunsight, Stephens County, Texas. Holotype, U. S. National Museum, No. 72247.

This species resembles *Cytherella benniei* var. *iowensis* J & K but differs in the rounded dorsal and ventral border and in that the posterior extremity is obtuse.

CYTHERELLA CALCAR Harlton, n. sp.
Plate 21, figs. 16 *a*, *b*

Shell small, inflated, suboblong in outline, rounded at both ends. Dorsal and ventral border straight; dorsal border slightly elevated near the posterior portion. The shell viewed from above is wedgelike, the anterior end being distinctly rounded. The overlap of the left valve by the right inconspicuous. Surface evenly convex, smooth. Length, 0.94 mm.; greatest height, 0.53 mm.; thickness 0.48 mm.

Graham formation, top of South Bend shale, below Gunsight limestone, 1 mile west of Graham, Young County, Texas. Holotype, U. S. National Museum, No. 72248.

The following corrections should be made in my paper in Volume One of this Journal:
Plate 52, figures 5 and 8 are interchanged.
Plate 53, figure 3 the first time should read "figure 1".

PRELIMINARY REPORT ON THE PALEONTOLOGY OF THE CHANNEL ISLANDS, CALIFORNIA

By LEO GEORGE HERTLEIN
California Academy of Sciences, San Francisco, California

ABSTRACT

This paper contains a brief discussion of the lower Miocene strata on Santa Rosa and San Miguel Islands off the coast of California. Two faunal zones are recognized, the *Turritella inezana* zone of the Vaqueros, lowermost Miocene, and the *Turritella ocoyana* zone of the Temblor which conformably overlies the Vaqueros. Ten new species of fossil Mollusks are described.

This paper is a report upon a preliminary study of some of the marine Miocene fossils found on Santa Rosa and San Miguel Islands off the coast of southern California. A more complete account of the Paleontology of these islands will appear at a later date.

The writer wishes to acknowledge assistance or advice received from Mr. A. M. Strong, Mr. F. M. Anderson and Mr. L. W. Wiedey, and to Dr. G. Dallas Hanna for assistance in the preparation of the manuscript and for the photography of the specimens. The types of the 10 new species described are in the type collection of the department of Paleontology of the California Academy of Sciences.

Marine beds composed chiefly of buff and gray sandstone and shale are present on Santa Rosa and San Miguel Islands and these strata contain fossils of Lower Miocene age. The Geology of Santa Rosa Island has been discussed recently by Kew.[1]

Sedimentary beds on both islands contain the *Turritella inezana* fauna of Vaqueros age and, a few hundred meters stratigraphically higher in conformable strata, the *Turritella ocoyana* fauna of Temblor age. The fauna of these strata is similar to that of the Lower Miocene of the mainland to the east. The stratigraphic distance between these two well defined zones differs somewhat on the two islands since the fossiliferous section on San Miguel Island is

[1] Oil Bulletin, vol. 13, no. 12, 1927, pp. 1257-1230 and p. 1330; Bull. Geol. Soc. Amer., vol. 38, no. 4, 1927, pp. 645-654.

apparently thinner than that on Santa Rosa Island. The *Turritella ocoyana* zone in San Augustine Canyon on Santa Rosa Island occurs about 300 to 400 meters above the base of the *Turritella inezana* zone, while on San Miguel Island the difference appears to be only about 150 meters.

A prominent oyster bed seems to be more or less a dividing line between the two zones although on San Miguel Island a *Turritella* resembling *T. ocoyana* Conrad, was collected a few meters below the oyster bed.

Noteworthy, is the fact that the genus *Rapana* is present in both zones on Santa Rosa Island. A preliminary study has shown the typical *Rapana vaquerosensis* Arnold only in the *Turritella inezana* zone while *R. imperialis* Hertlein and Jordan is more commonly found in the *T. ocoyana* zone.

Another interesting occurrence is that of *Turritella tritschi* Hertlein, a very carinate form, which occurs about 40 meters stratigraphically below the *Turritella inezana* zone.

OSTREA ENGLEKYI Hertlein, n. sp.
Plate 25, fig. 1

Shell elongate triangular. Lower valve thick, made up of flattish layers of shell material, thickest in middle part of valve; sides of valve fairly straight. Left valve thinner but otherwise similar to right valve. Altitude 143.4 mm.; width of ventral margin of shell 86 mm.

Holotype (No. 4116, C. A. S. type collection), from Loc. 1156 (C. A. S.), about .4 kilometer southeast of spring (near Loc. 1154 C. A. S.), east of dike, near top of hill, Santa Rosa Island, California, L. G. Hertlein and E. L. Rixford collectors; Temblor, Lower Miocene.

The hinge of *Ostrea englekyi* is not fully exposed but it apparently belongs to the *Ostrea virginica* Gmelin group. It differs from that species in its extremely triangular shape, straight sides and thick shell. From *O. freudenbergi* Hertlein & Jordan,[2] *O. englekyi* differs in its larger size, greater thickness and straight sides and different hinge. The present species is apparently not close to *O. chilensis* Philippi[3] in the early part of shell nor in general shape. *O. englekyi* most closely resembles a species of recent *Ostrea* which is found in the Gulf of California apparently differing only in minor details. The triangular shape, narrower ligament pit and wider anterior margin

[2] Proc. Calif. Acad. Sci., 4th Ser., vol. 16, no. 19, 1927, p. 622, pl. 17, fig. 9; pl. 18, fig. 4.
[3] See Dall, Proc. U. S. Nat. Mus., vol. 37, 1910, p. 255, pl. 26, fig. 1.

distinguish *O. englekyi* from *O. californica* Marcou,[4] a species once reported by Hanna[5] as *O. iridescens* Gray but later recognized[6] as distinct from Gray's recent species.

This species is named for Mr. Walter Engleky of the California State Fish and Game Commission, Captain of the boat *Albacore*, who extended many kindnesses to the author.

OSTREA LOELI Hertlein, n. sp.
Plate 22, figs. 1, 3

Shell quadrate, thick, slightly arched; made up of many layers of shell material; shell shows about 6 coarse, radial, corrugations which are but little developed or absent in the early part of shell but which are pronounced in the adult. Ligament pit broad, prominent, distinctly depressed; body cavity sharply depressed on one side; muscle scar large, depressed, situated on posterior side of shell about one third the length of shell from ventral margin. Height, 130 mm.; length, 100 mm.; thickness, lower valve, 38 mm.

Holotype, lower valve (No. 4117 and paratypes Nos. 4118, 4119, 4120, C. A. S. type collection), from Loc. 1153 (C. A. S.). In bed of creek, about 1.6 to 2 kilometers up canyon from mouth of San Augustine Canyon, Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors; Vaqueros formation, Lower Miocene.

This heavy oyster resembles *Ostrea heermanni* Conrad[7] from the Pliocene of Imperial County, California but it is more quadrate in outline, thicker, and it possesses fewer and heavier plications which

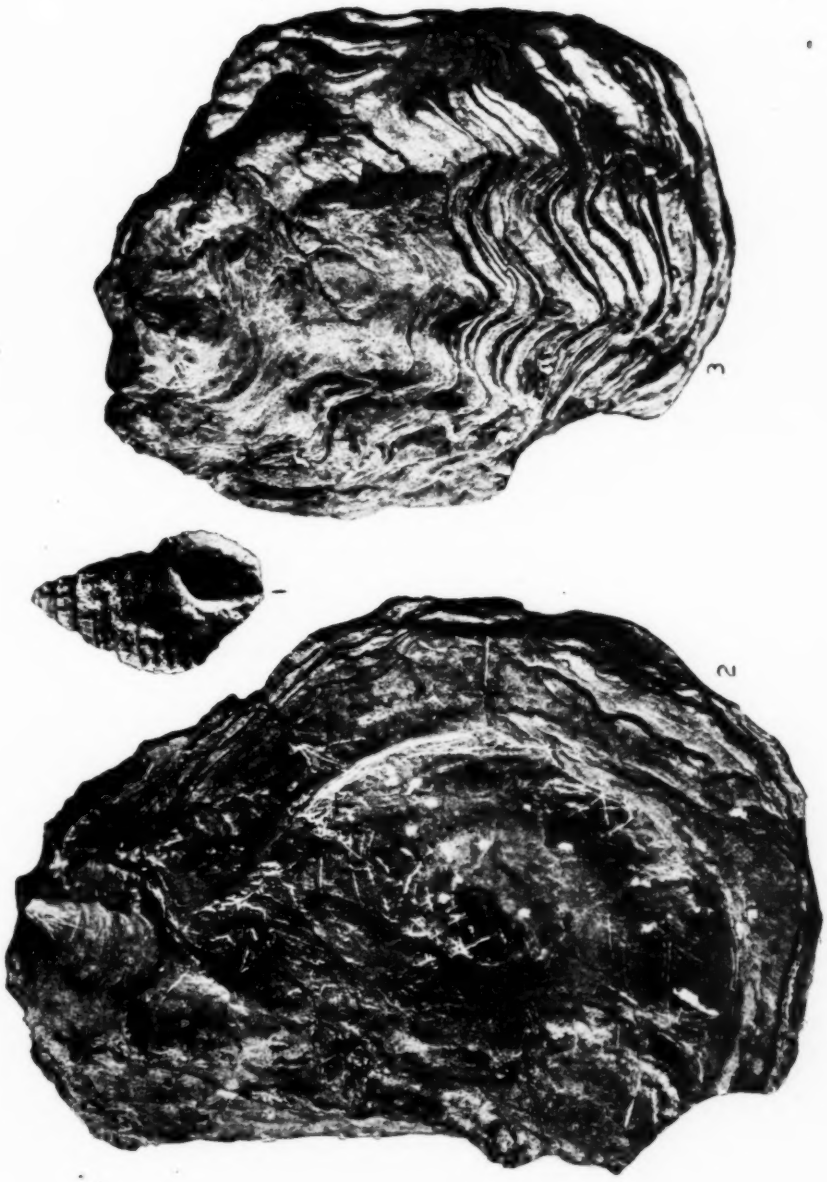
[4] Geol. North America, 1858, Zurich., p. 32, pl. 5, figs. 2, 2a.
[5] Proc. Calif. Acad. Sci., 4th Ser., vol. 14, no. 18, 1926, p. 468, pl. 26, figs. 4-7.
[6] Nautilus, vol. 41, no. 2, 1927, pp. 45-47.
[7] See Proc. Calif. Acad. Sci., 4th Ser., vol. 14, no. 18, 1926, p. 467, pl. 22, figs. 7, 8; pl. 23, figs. 1, 2.

EXPLANATION OF PLATE 22

FIG. 1.—*Ostrea loeli* Hertlein, n. sp.; height of specimen, 153 mm. Paratype, no. 4118 (C. A. S. type collection), from Loc. 1153 (C. A. S.), in bed of creek, about 1.6 to 2 kilometers up canyon from mouth of San Augustine Canyon, Santa Rosa Island, California. Vaqueros, Lower Miocene.

2.—*Alectrion churchi* Hertlein, n. sp.; height of specimen, 4.9 mm. Holotype, no. 4149 (C. A. S. type collection), from beds on shore about .5 kilometer west of mouth of Arlington Canyon, Santa Rosa Island, California. Vaqueros, Lower Miocene.

3.—*Ostrea loeli* Hertlein, n. sp.; height of specimen, 130 mm. Holotype no. 4117 (C. A. S. type collection); from same locality as fig. 1.



are prominent only on the ventral part of the shell; it also has a distinctly depressed body cavity and longer hinge line.

This species is named for Mr. Wayne Loel who has done much stratigraphic work on the Lower Miocene of California.

OSTREA MIGUELENSIS Hertlein, n. sp.
Plate 23, figs. 3, 4, 5, 6

Shell small; obliquely subovate, beaks pointed; shell fairly thick. Lower valve convex, a slight groove runs from beak to umbo, two or three irregular projections of shell material are irregularly scattered on valve, ornamentation consists of fine lamellar edges of shell. Upper valve gently concave with a small raised median ridge which runs from the beak for one third the length of shell, otherwise ornamented only by the incremental shell lamellae. Height from beak to base, 21.5 mm.; greatest anterior-dorsal width, 21 mm.; convexity of valves, 9.1 mm.

Holotype (No. 4121 and paratypes Nos. 4122, 4123, 4124, 4125, 4216, 4127, C. A. S. type collection) from Loc. 1163 (C. A. S.) from *Pecten miguelensis* bed which is about 33 meters stratigraphically above the *Turritella inezana* zone just east of Crook Point, San Miguel Island, California; also paratype No. 4128 (C. A. S. type collection) from Loc. 1164 (C. A. S.) beds between Loc. 1163 (C. A. S.) and oyster bed which is about 100 to 135 meters stratigraphically above Loc. 1163 (C. A. S.), along edge of mesa, San Miguel Island, California; L. G. Hertlein and E. L. Rixford collectors; Vaqueros, Lower Miocene.

This small oyster occurs quite commonly at Loc. 1163 (C. A. S.). In many of its features it seems to resemble *O.idriaensis* Gabb,[8] from the Upper Eocene but it is much smaller and commonly possesses a median ridge on the upper valve. *O. miguelensis* resembles the early part of *O. bourgeoisii* Remond,[9] from the Upper Miocene of California but is more ovate and does not attain a large size; many of the specimens are not ornamented except for the incremental lines of growth. In some specimens the beaks turn anteriorly, in others posteriorly; apparently the direction depends upon the position assumed at the time of attachment. The raised median ridge on the upper valve appears to be an unusual feature in this interesting little shell.

[8] Geol. Surv. Calif. Paleo., vol. 2, 1869, p. 203, pl. 33, figs. 103b, c, d; pl. 34, figs. 103, 103a.

[9] Proc. Calif. Acad. Nat. Sci., vol. 3, pt. 1, 1863, p. 13; See Geol. Surv. Calif. Paleo., vol. 2, 1869, p. 33, pl. 11, figs. 57, 57a.

OSTREA WIEDEYI Hertlein, n. sp.
Plate 23, figs. 1, 10

Shell moderately large, oblong, moderately thick, flattish; surface marked by 10 to 15 deep radiating plications which have a tendency to become nodose, some of the ribs arise at or near the beaks, others branch from the earlier ones or are interpolated between them; interspaces angular; the ribs internally show only toward the margin. Hinge subtriangular, fairly broad, moderately impressed. Muscle scar large, suboval to subquadrate. Altitude 151 mm.; length 69 mm.; thickness of lower valve 31.5 mm.

Holotype (No. 4129 and paratypes Nos. 4130, 4131, 4132, 4133, 4134, 4135, 4136, 4137, 4138, C. A. S. type collection), from Loc. 1154 (C. A. S.) from oyster bed near spring on ridge to south of San Augustine Canyon, about 1.6 to 2 kilometers from mouth of canyon, Santa Rosa Island, California. L. G. Hertlein and E. L. Rixford collectors; Vaqueros, Lower Miocene.

This species differs from *O. vespertina* Conrad[10] in its thicker more elongate shell and longer ligament pit. It differs from *O. heermanni* Conrad;[11] by its elongate form, thinner shell and longer ligament pit. From *O. howelli* Wiedey[12] it differs in being a much larger shell, ornamented by more numerous branching corrugations rather than the few straight corrugations on Wiedey's species.

Ostrea wiedeyi is extremely variable from a subovate form ornamented by 12 to 15 radial, nodose plications to a long narrow shell with six to eight plications. The ligament pit also varies with the shape of the shell; in the subovate forms it is a short, turned up triangular pit and in the long shells it is a broad fairly deep and slightly depressed scar. These forms all occur in the same zone and apparently the great variation is due to differences in the swiftness of the water currents in which they grew.[13]

The small ovate forms of *O. wiedeyi* resemble *O. vespertina* Conrad[14] but that shell usually has a thicker and larger shell and a greater tendency to adopt an elongate form; also the ligament pit in the present species is often quite depressed, narrowly triangular and longer. Furthermore, the margins of the shell are not plicated as in *O. vespertina* Conrad.

[10] Jour. Acad. Nat. Sci. Phila., 2nd Ser., vol. 2, 1854, p. 300; Proc. Calif. Acad. Sci., 4th Ser., vol. 15, no. 14, 1926, p. 428.

[11] See Proc. Calif. Acad. Sci., 4th Ser., vol. 14, no. 18, 1926, p. 467, pl. 22, figs. 7, 8; pl. 23, figs. 1, 2.

[12] Trans. San Diego Soc. Nat. Hist., vol. 5, no. 10, 1928, p. 135, pl. 15, figs. 1 and 2.

[14] Jour. Acad. Nat. Sci. Phila., 2nd Ser., vol. 2, 1854, p. 300; Proc. Calif. Acad. Sci., 4th Ser., vol. 15, no. 14, 1926, p. 428.

[13] Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, 1898, pp. 675-676.

This species is named for Mr. L. W. Wiedey in recognition of his work on the faunas of the Lower Miocene.

PLACUNANOMIA GRANTI Hertlein, n. sp.
Plate 23, figs. 7, 8, 9

Shell moderately small, subcircular in outline, inequivalve, compressed. Upper valve slightly convex; surface irregularly wrinkled. Lower valve slightly concave, sculpture similar to right. A short depressed groove is present on the beak. Altitude, 34 mm.; length, 29 mm.

Holotype (No. 4139 and paratypes Nos. 4140, 4141 C. A. S. type

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EXPLANATION OF PLATE 23

FIG. 1.—*Ostrea wiedeyi* Hertlein, n. sp.; height of specimen, 151 mm. Holotype, no. 4129 (C. A. S. type collection), from Loc. 1154 (C. A. S.), from oyster bed near spring on ridge to south of San Augustine Canyon, about 1.6 to 2 kilometers from mouth of canyon Santa Rosa Island, California. Vaqueros, Lower Miocene.

2.—*Fissurella rixfordi* Hertlein, n. sp.; height of specimen, 9 mm. Holotype, no. 4145 (C. A. S. type collection), from Loc. 1164 (C. A. S.), beds along edge of plateau about 160 meters stratigraphically above *Pecten miguelensis* bed near Crook Harbor, San Miguel Island, California. Lower Miocene.

3.—*Ostrea miguelensis* Hertlein, n. sp.; height of specimen, 30 mm. Paratype, no. 4122 (C. A. S. type collection), from Loc. 1163 (C. A. S.), from *Pecten miguelensis* bed about 33 meters stratigraphically above the *Turritella inezana* zone just east of Crook Point, San Miguel Island, California. Vaqueros, Lower Miocene.

4.—*Ostrea miguelensis* Hertlein, n. sp. Lower valve of specimen shown in fig. 3.

5.—*Ostrea miguelensis* Hertlein, n. sp.; height, 21.5. Holotype, no. 4121 (C. A. S. type collection); from same locality as fig. 3.

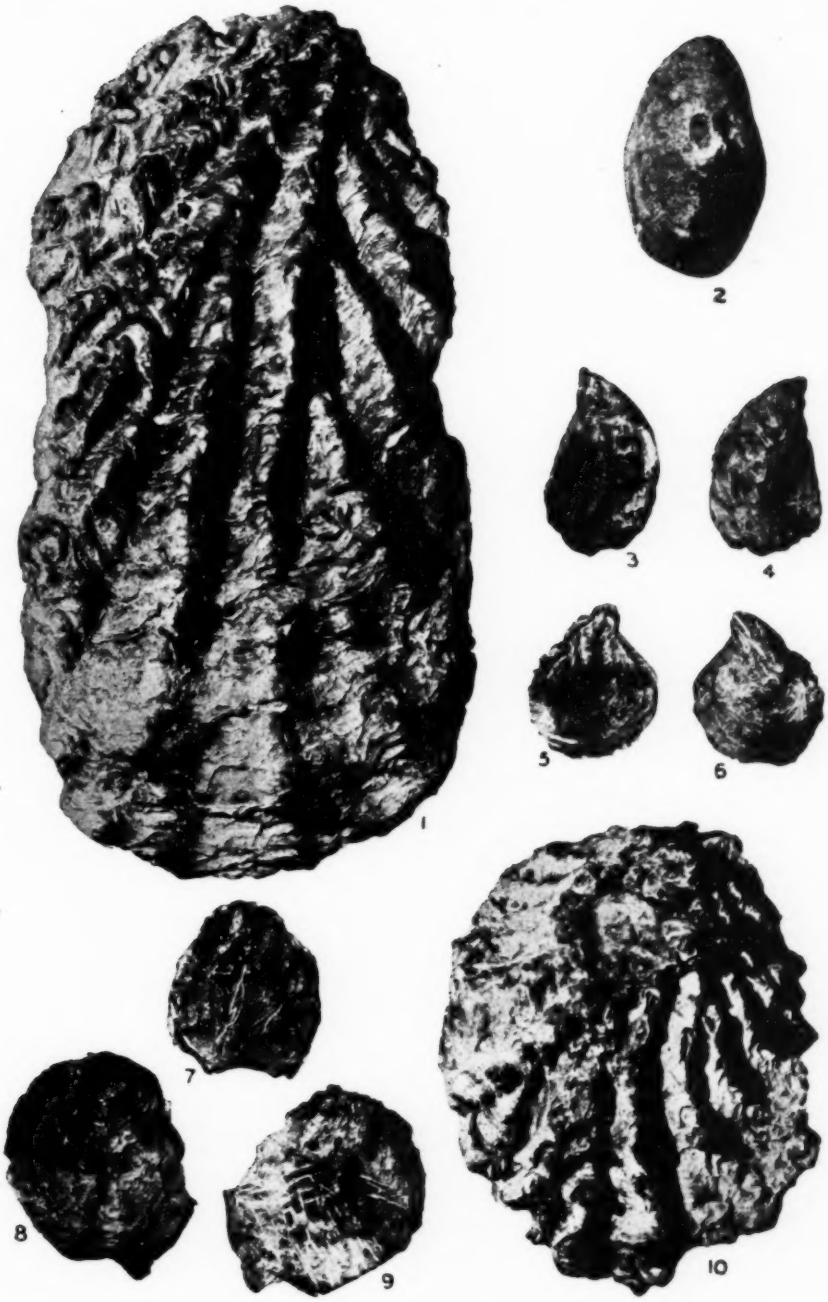
6.—*Ostrea miguelensis* Hertlein, n. sp.; lower valve of specimen shown in fig. 5.

7.—*Placunanomia granti* Hertlein, n. sp.; height of specimen, 30 mm. Paratype, no. 4140 (C. A. S. type collection), from Loc. 1150 (C. A. S.), beds on shore about .5 kilometer west of mouth of Arlington Canyon, Santa Rosa Island, California. Vaqueros, Lower Miocene.

8.—*Placunanomia granti* Hertlein, n. sp.; height of specimen, 34 mm. Holotype, no. 4139 (C. A. S. type collection); from same locality as fig. 7.

9.—*Placunanomia granti* Hertlein, n. sp.; opposite valve of specimen shown in fig. 8.

10.—*Ostrea wiedeyi* Hertlein, n. sp.; height of specimen, 78 mm. Paratype no. 4130 (C. A. S. type collection); from same locality as fig. 1.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collection) from Loc. 1150 (C. A. S.) from beds on shore about .3 kilometer west of mouth of Arlington Canyon, Santa Rosa Island, California. L. G. Hertlein and E. L. Rixford collectors; Vaqueros, Lower Miocene.

This small and rather irregularly faintly plicated species does not resemble closely any other west coast *Placunanomia*. It does not show the radial striations of *P. californica* Arnold[15] and is smaller and more corrugated than *P. hannibali* Jordan & Hertlein.[16]

This species is named for Mr. U. S. Grant IV of San Diego, California.

PTERIA ROSITAE Hertlein, n. sp.

Plate 25, fig. 3

Shell oblique, triangular, with long produced wing; hinge line long and straight; surface ornamented by incremental lines of growth. Beak near anterior fourth, prominent, oblique; shell slopes rather rapidly posteriorly from beak; anteriorly the beak slopes abruptly to a small byssal fold forming a groove which separates the anterior auricle from shell; auricle triangular, obliquely truncate; byssal notch small, not pronounced. Height, 26.9 mm.; length of hinge line (incomplete at both ends), 43 mm.

Holotype (Cast of right valve, no. 4142, C. A. S. type collection), from near Loc. 1156 (C. A. S.) top of ridge to southwest of spring, about 1.6 to 2 kilometers from mouth of San Augustine Canyon, Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors. Temblor, Lower Miocene.

This species differs from *P. sterna* Gould,[17] in that the anterior ventral part of the shell drops abruptly and is directly in line with the byssal sinus while in *P. sterna* Gould, the anterior ventral part of the shell extends broadly anterior and the byssal groove runs obliquely anterior from the beak. It is much broader ventrally and much more extended posteriorly than *P. peruviana* Reeve.[18]

This species is named for the island where the type was collected.

[15] U. S. Geol. Surv. Bull. 396, 1909, p. 75, pl. 24, figs. 2, 2a and 3.

[16] Proc. Calif. Acad. Sci., 4th Ser., vol. 15, no. 14, 1926, p. 443, pl. 28, figs. 2, 3, 4.

[17] Proc. Bost. Soc. Nat. Hist., vol. 4, 1851, p. 93; Boston Jour. Nat. Hist., vol. 6, 1853, pl. 16, fig. 7; Stanford Univ. Pub. Geol., vol. 1, no. 1, 1924, p. 48, pl. 40, fig. 3.

[18] Conch. Icon., vol. 10, 1857, pl. 14, sp. 53; Proc. U. S. Nat. Mus., vol. 37, 1910, p. 255, pl. 28, fig. 1.

PECTEN (LYROPECTEN) MIGUELENSIS Arnold

Plate 24, fig. 1

1898. *Pecten (Lyropecten) heermanni* DALL, (not CONRAD), Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, 1898, p. 701; (not of CONRAD).

1906. *Pecten (Lyropecten) miguelensis* ARNOLD, U. S. Geol. Surv. Prof. Paper 47, 1906, p. 79, pl. 22, figs. 1, 1 *a*, 1 *b;* pl. 23, fig. 1. San Miguel Island.

1907. *Pecten* cf. *miguelensis* ARNOLD, U. S. Nat. Mus. Proc., vol. 32, 1907, p. 526.

1907. *Pecten* cf. *miguelensis* ARNOLD, U. S. Geol. Surv. Bull. 309, 1907, p. 147.

Plesiotype (No. 4143, C. A. S. type collection), from Loc. 1156 (C. A. S.) about .4 kilometer southeast of spring (near Loc. 1154 C. A. S), east of dike, near top of hill, Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors; Temblor, Lower Miocene.

This fine species occurs abundantly at various localities on Santa Rosa Island and is also present on San Miguel Island. It differs from *P. estrellanus* Conrad in the details which Arnold[19] stated so well: "This species is distinguishable from *P. estrellanus* and others of the same group by its larger size, inequality of valves (which are more or less inequilateral), and radially striate surface from umbo to periphery. It sometimes shows the constrictions common to *P. estrellanus.*"

The type of *P. miguelensis* Arnold came from San Miguel Island.

CYTHEREA (CYTHEREA) sp.

Plate 24, fig. 6

Plesiotype (No. 4144, C. A. S. type collection) from Loc. 1156 (C. A. S.) about .4 kilometer southeast of spring (Loc. 1154 C. A. S.), east of dike, and near top of hill, Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors; Temblor, Lower Miocene. The plesiotype is an excellent cast which clearly shows the sculpture. The shape, reticulate sculpture and groove running down the umbos seems to place the species in the genus *Cytherea* Bolten s. s. The species is different from any known from west coast Miocene but since the specimens are casts it is not described.

FISSURELLA RIXFORDI Hertlein, n. sp.

Plate 23, fig. 2

Shell subelliptical, moderately elevated; apex somewhat anterior. Radially sculptured by numerous close, fine, even ribs; these are

[19] U. S. Geol. Surv. Prof. Paper 47, 1906, p. 79, pl. 22, figs. 1, 1a, 1b; pl. 33, fig. 1.

crossed by very fine, concentric lines. Apical orifice moderately large, elliptical, anterior to apex. Length, 38.5 mm.; altitude, 9 mm.; width, 23 mm.

Holotype (No. 4145, C. A. S. type collection) from Loc. 1164 (C. A. S.); beds along edge of plateau about 160 meters stratigraphically above *Pecten miguelensis* bed near Crook Harbor, San Miguel Island, California; L. G. Hertlein and E. L. Rixford collectors; lower Miocene.

The type of this species is an excellent cast which shows the ornamentation. It differs from *F. volcano* Reeve,[20] a recent species, in its larger size, lower apex, and larger and more anteriorly situated orifice; furthermore, the present species possesses many more ribs than are found in Reeve's species.

This species is named for Mr. Emmet L. Rixford who assisted the author in making collections on the Channel Islands.

[20] Conch. Icon., vol. 6, 1849, Fissurella, pl. 4, sp. 2.

EXPLANATION OF PLATE 24

FIG. 1.—*Pecten (Lyropecten) miguelensis* Arnold; height of specimen, 135 mm.; ears partially incomplete. Plesiotype, no. 4143 (C. A. S. type collection) from Loc. 1156 (C. A. S.) about .4 kilometer southeast of spring (near Loc. 1154 C. A. S.), east of dike, near top of hill, Santa Rosa Island, California. Temblor, Lower Miocene.

2.—*Turritella tritschi* Hertlein, n. sp.; height of specimen, 22 mm. Holotype, No. 4150 (C. A. S. type collection) from Loc. 1152 (C. A. S.) about seventy-five meters downstream from *Turritella inezana* bed in San Augustine Canyon, about 1.6 to 2 kilometers above mouth of canyon, Santa Rosa Island, California. Vaqueros, Lower Miocene.

3.—*Turritella tritschi* Hertlein, n. sp.; photograph of same specimen as fig. 2.

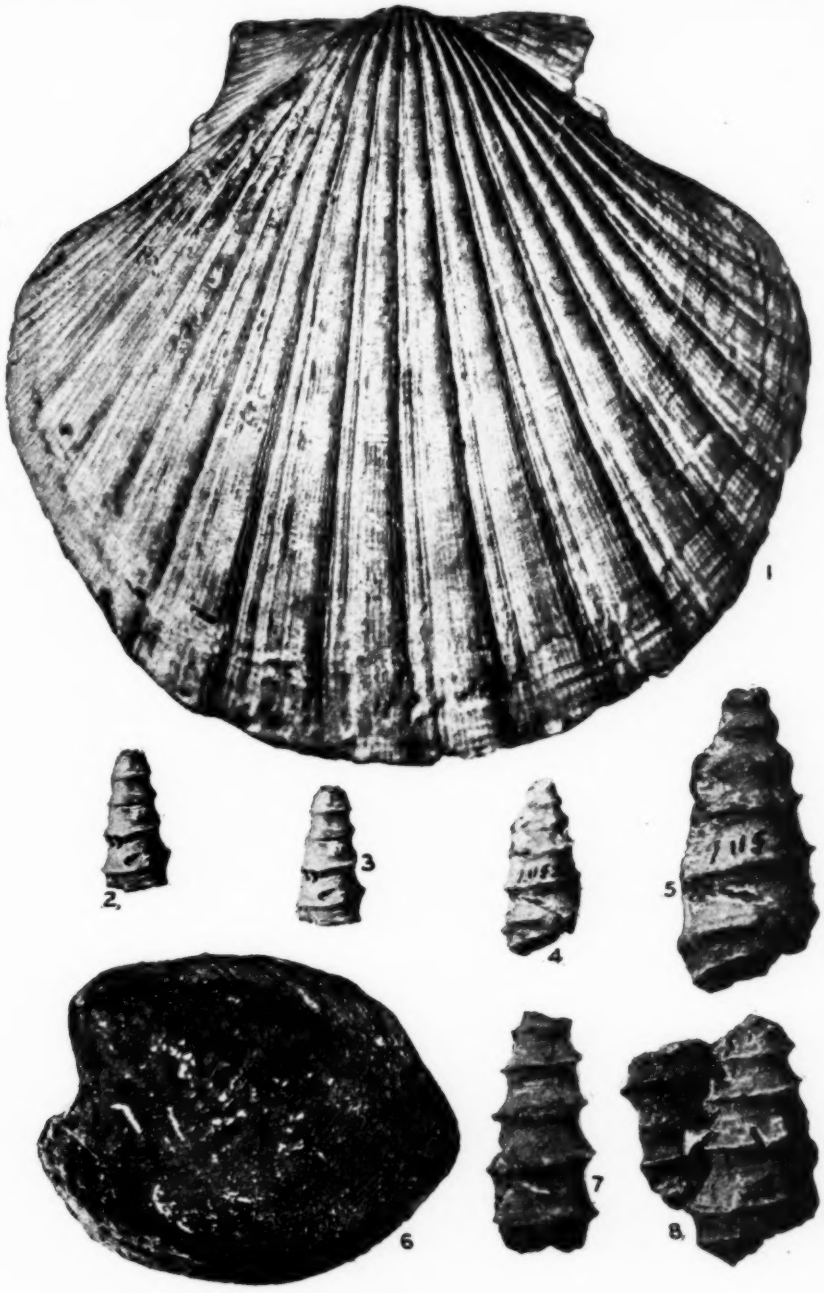
4.—*Turritella tritschi* Hertlein, n. sp.; height of specimen, 23 mm. Paratype, no. 4151 (C. A. S. type collection); from same locality as fig. 3.

5.—*Turritella tritschi* Hertlein, n. sp.; same specimen as fig 4, enlarged view.

6.—*Cytherea* sp.; length of specimen, 70 mm. Plesiotype, no. 4144 (C. A. S. type collection) from Loc. 1156 (C. A. S.) about .4 kilometer southeast of spring (Loc. 1154 C. A. S.), east of dike and near top of hill, Santa Rosa Island, California Temblor, Lower Miocene.

7.—*Turritella tritschi* Hertlein, n. sp.; same specimen as fig. 2, enlarged view.

8.—*Turritella tritschi* Hertlein, n. sp.; height of specimen 24 mm. Paratype, no. 4152 (C. A. S. type collection); from same locality as fig. 2.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CALLIOSTOMA AUGUSTINENSIS Hertlein, n. sp.
Plate 25, figs. 4, 5

Shell rather low-conic, imperforate, fairly thin; about 4 rounded whorls present; body whorl broadly rounded below; surface with numerous, fine, even, spiral, flattish topped ribs which are separated by smaller fine lines. Height, 21 mm.; length, 29 mm.

Holotype (No. 4146 and paratypes Nos. 4147, 4148, C. A. S. type collection) from Loc. 1154 (C. A. S.) lower part of oyster beds on slope of ridge near spring on south side of San Augustine Canyon, about 9.6 kilometers south of ranch house, Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors; Vaqueros, Lower Miocene.

This species differs from *Calliostoma costatum* Martyn,[21] in its lower spire and very numerous fine spiral ribs. These characters also distinguish it from *C. pacificum* Anderson & Martin.[22]

[21] Universal Conchology, 1784, table 1, pl. 34; Stanford Univ. Pub. Geol., vol. 2, pt. 3, 1927, p. 183, pl. 97, figs. 8, 10.
[22] Proc. Calif. Acad. Sci., 4th Ser., vol. 4, 1914, p. 64, pl. 8, figs. 2a, 2b.

EXPLANATION OF PLATE 25

FIG. 1.—*Ostrea englekyi* Hertlein, n. sp.; height of specimen, 143.4 mm. Holotype, no. 4116 (C. A. S. collection), from Loc. 1156 (C. A. S.) about .4 kilometer southeast of spring (near Loc. 1154 C. A. S.) east of dike, near top of hill, Santa Rosa Island, California. Temblor, Lower Miocene.

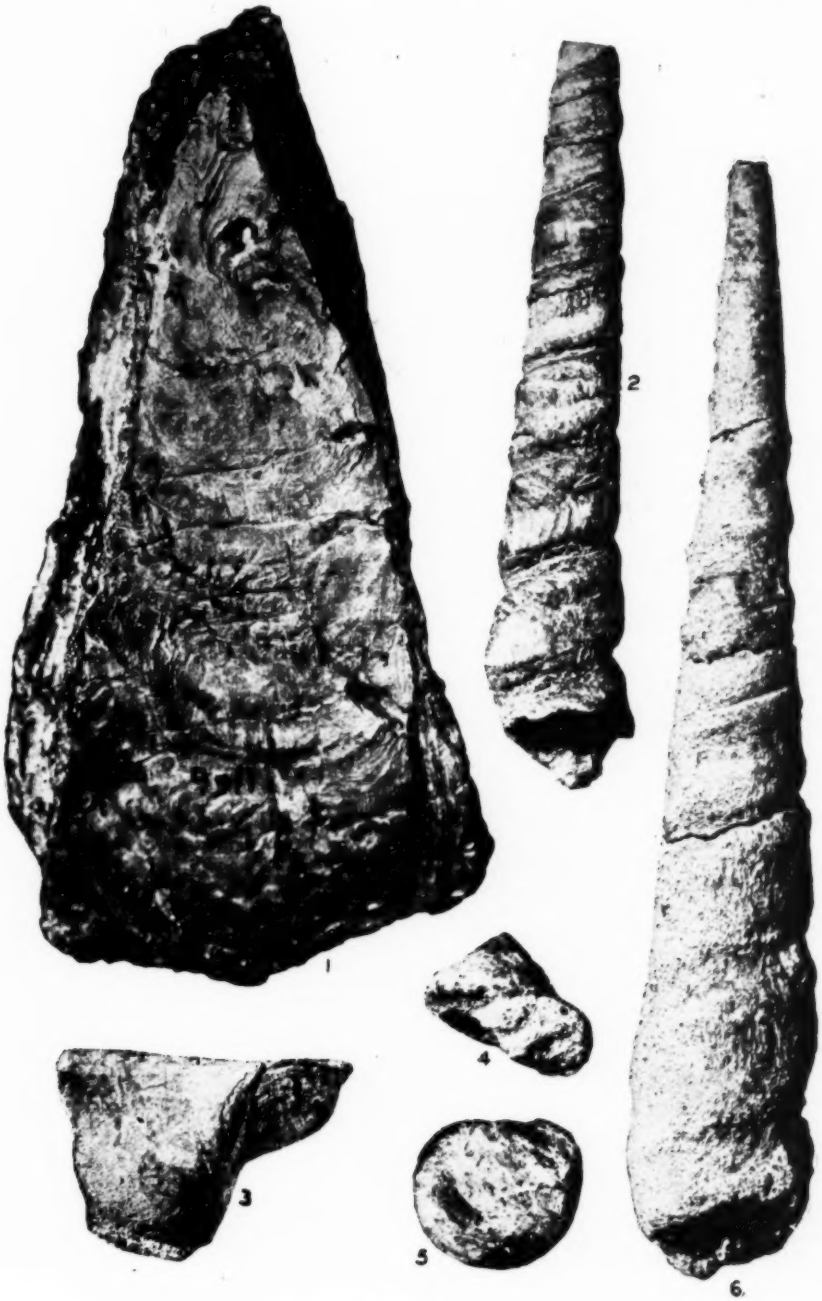
2.—*Turritella inezana* Conrad; height of specimen, 122 mm. Plesiotype, no. 4156 (C. A. S. type collection), from Loc. 1153 (C. A. S.) *Turritella inezana* bed at bottom of San Augustine Canyon, about 1.6 to 2 kilometers from mouth of canyon, on south side of Santa Rosa Island, California. Vaqueros, Lower Miocene.

3.—*Pteria rositae* Hertlein, n. sp.; height of specimen, 26.9 mm. Holotype, no. 4142 (C. A. S. type collection), from near Loc. 1156 (C. A. S.), top of ridge to southwest of spring, about 1.6 to 2 kilometers from mouth of San Augustine Canyon, Santa Rosa Island, California. Temblor, Lower Miocene.

4.—*Calliostoma augustinensis* Hertlein, n. sp.; height of specimen, 21 mm. Holotype, no. 4146 (C. A. S. type collection), from Loc. 1154 (C. A. S.), lower part of oyster beds on slope of ridge near spring on south side of San Augustine Canyon, about 9.6 kilometers south of ranch house and 1.6 to 2 kilometers from mouth of San Augustine Canyon, Santa Rosa Island, California. Vaqueros, Lower Miocene.

5.—*Calliostoma augustinensis* Hertlein, n. sp.; basal view of specimen in fig. 4.

6.—*Turritella inezana* Conrad; height of specimen, 143 mm. Plesiotype, no. 4157 (C. A. S. type of collection); from same locality as fig. 2.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ALECTRION CHURCHI Hertlein, n. sp.
Plate 22, fig. 2

Shell small; subovate; spire conical, elevated, five nodose whorls; whorls slightly rounded not tabulated, ornamented with about three equally spaced spiral ribs and crossed by axial ribs which are more prominent than the spiral sculpture, producing nodes at the intersections; suture impressed; body whorl ventricose and sculptured by about 12 axial ribs, these crossed by revolving ribs of less prominence; aperture elliptical; outer lip thickened by varix; inner lip apparently smooth; columella short, possessing a small anterior sulcus; canal short. Altitude, 4.9 mm.; width of body whorl, 2.9 mm.

Holotype (No. 4149, C. A. S. type collection), from Loc. 1150 (C. A. S.), beds on shore about .5 kilometer west of mouth of Arlington Canyon, Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors; Vaqueros, Lower Miocene.

This species closely resembles *A. antiselli* Anderson & Martin,[23] from the lower Miocene of San Luis Obispo County, but differs in its smaller size, finer sculpture, rounder whorls and more rounded body whorl. The rounded whorls and depressed suture of *A. churchi* contrast strongly with the definite shoulder on *A. blakei* Anderson & Martin.[24]

This species is named for Mr. C. C. Church, Paleontologist of the Associated Oil Company, San Francisco, California.

TURRITELLA TRITSCHI Hertlein, n. sp.
Plate 24, figs. 2, 3, 4, 5, 7, 8

Shell small, whorls extremely carinated, the carina occurring about three fourths the length from top of whorl. Sculpture consists of about five or six fine revolving ribs. Columella short. Length (apex broken), 22 mm.

Holotype (No. 4150, and *paratypes:* Nos. 4151, 4152, 4153, 4154, 4155, C. A. S. type collection), from Loc. 1152 (C. A. S.), about seventy five meters down stream from *Turritella inezana* bed in San Augustine Canyon; about 1.6 kilometers above mouth of Canyon, Santa Rosa Island, California. L. G. Hertlein and E. L. Rixford collectors; Vaqueros, Lower Miocene.

This species is smaller and has finer sculpture than *T. bösei* Hertlein & Jordan.[25] It may be distinguished by its much smaller size, finer spiral ribs and extremely carinate whorls. It is especially inter-

[23] Proc. Calif. Acad. Sci., 4th Ser., vol. 4, 1914, p. 76, pl. 7, fig. 16.
[24] Proc. Calif. Acad. Sci., 4th Ser., vol. 4, 1914, p. 76, pl. 7, figs. 15a, 15b.
[25] Proc. Calif. Acad. Sci., 4th Ser., vol. 16, no. 19, 1927, p. 634, pl. 21, figs. 1 and 2.

esting since it occurs about 40 meters stratigraphically below the *Turritella inezana* zone. The specimens came from a hard limestone layer and are rather difficult to extract completely.

Possibly this is the species mentioned by Arnold[26] and which he referred to the young of *T. variata* Conrad, from the Vaqueros formation from the western end of the Santa Ynez Range. *T. tritschi* differs from *T. temblorensis* Wiedey[27] in that Wiedey's species is larger, possesses heavy spiral ribs and lacks the extreme carina found on the present species.

TURRITELLA INEZANA Conrad

Plate 25, figs. 2, 6

1857. *Turritella inezana* CONRAD, Pac. R. R. Repts., vol. 7, pt. 2, 1857, p. 195, pl. 8, fig. 4. "Santa Inez Mountains."
1869. *Turritella hoffmannii* GABB, Geol. Surv. Calif. Paleo., vol. 2, 1869, p. 14, pl. 2, fig. 24. "From a white Miocene limestone in the extreme southern corner of the Maxima Martiñez Rancho, Santa Clara County."
1907. *Turritella ineziana* CONRAD, ARNOLD, U. S. Geol. Surv. Bull. 309, 1907, p. 14, 17; pl. 41, figs. 4, 5.
1907. *Turritella ineziana* CONRAD, ARNOLD, U. S. Nat. Mus. Proc., vol. 32, 1907, pl. 51, figs. 4, 5.
1907. *Turritella ineziana* CONRAD, ARNOLD, U. S. Geol. Surv. Bull. 322, 1907, p. 33, pl. 16, fig. 3.
1907. *Turritella ineziana* CONRAD, ARNOLD, Smithson Misc. Coll., vol. 50, 1907, p. 421.
1908. *Turritella ineziana* CONRAD, ARNOLD, U. S. Nat. Mus. Proc., vol. 34, 1908, p. 350, pl. 34, fig. 6.
1912. *Turritella inezana* CONRAD, SMITH, Proc. Calif. Acad. Sci., 4th ser., vol. 3, 1912, pp. 165, 177, 179.
1926. *Turritella inezana* CONRAD, STEWART, Proc. Acad. Nat. Sci. Phila., vol. 78, 1926, p. 350, pl. 31, fig. 7.
1928. *Turritella inezana* CONRAD, WIEDEY, Trans. San Diego Soc. Nat. Hist., vol. 5, no. 10, 1928, pl. 12, figs. 2, 3, 7.

Plesiotypes (Nos. 4156, 4157, C. A. S. type collection) from Loc. 1153 (C. A. S.) in bottom of San Augustine Canyon about 1.6 to 2 kilometers from mouth of canyon, on south side of Santa Rosa Island, California; L. G. Hertlein and E. L. Rixford collectors. Vaqueros, Lower Miocene.

This excellent species occurs abundantly on Santa Rosa Island, especially at Loc. 1153 (C. A. S.), in San Augustine Canyon. Here as elsewhere in the Vaqueros of this and San Miguel islands, it is in or near the lowest fossil bearing strata.

[26] Smithson Misc. Coll., vol. 50, 1907, p. 421.
[27] Trans. San Diego Soc. Nat. Hist., vol. 5, no. 10, 1928, p. 122, pl. 11, figs. 4, 7, 8, 9.

THE BIOSTRATIGRAPHIC ASPECT OF MICROPALEONTOLOGY*

* Read before the Society of Economic Paleontologists and Mineralogists, San Francisco, California, March 22, 1928.

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ABSTRACT

The determination of ecologic conditions should be considered in correlations of formations. Changes in homeotopic faunas are of the greatest chronologic value.

Paleontology is the science which treats of the life which has existed on the globe during former geological periods. It deals with all questions concerning the structure, classification, relationships, descent, conditions of existence, and distribution, as well as with those theories of organic and cosmogenic evolution which result from such inquiries (1).[1] Paleontology is more nearly related to zoölogy and botany, on the one hand, and to geology on the other. For these two major divisions of paleontology Dollo proposed the two terms "Paleobiology" and "Biostratigraphy" (2).

The foundation of biostratigraphy is the study of life in its historical sequence and in relation to its environment (2). The subject deals with such problems as the reconstruction of life districts, recognition of facies within the same district, climatic relations, and the principles underlying the correlations of geologic formations. Biostratigraphy is not as concerned with problems of classification and relationships as is paleobiology.

Micropaleontology should, in no way, radically depart from the general field and fundamental principles of paleontology. It is merely a study of the smaller fossils whose characteristic features are studied by the aid of a microscope. Since the chief practical importance of paleontology is the bearing it has on correlation, and since

[1] The numbers in parenthesis refer to the accompanying list of literature cited.

this depends to a great extent upon the recognition of species, more attention is placed by most workers upon the identification of species and the determination of their stratigraphic distribution. Yet a knowledge of life habits, modes of propagation, and environmental conditions is also important. For example, many paleontologists realize the significant fact that difference in habitat rather than difference in time will cause two faunas to be unlike, at the same time realizing the importance of taking faunal provinces into account. Yet we may turn to a recent paper (3) dealing with methods of correlation by means of Foraminifera and read the statement that large numbers of *Cassidulina* indicate Pliocene. However, the Pliocene rocks of the Philippine Islands are not, as far as the writer is aware, characterized by large numbers of this genus. The Philippines are situated in a different faunal province and the rocks represent a different facies from that where *Cassidulina* occurs in large numbers. This appears to be true with the Pliocene of Italy as well (4).

Little doubt is held that the larger Foraminifera are valuable in interregional correlation when similar facies and faunal provinces are compared. One instance is striking. Several years ago the writer submitted some orbitoidal Foraminifera to Professor Henri Douvillé in Paris with the request that he identify both the genus and the horizon. He was not informed that the formation in California from which they were obtained is regarded as upper (Tejon) Eocene. His reply was that the genus is "Orthophragmina" and that the horizon is "Éocène supérieur." This correct determination of age is the more striking because he had not before heard of the occurrence of the genus in upper California. We are also quite aware that the smaller Foraminifera may be employed in similar correlations if species from that horizon are described and if the species come from the same province and facies. However, if material containing only smaller Foraminifera should be sent to the best authority from an unknown locality in a little studied faunal province, and if no indication is given as to approximate geographic and stratigraphic location, the chances are that the specialist cannot positively identify the horizon from which the material was obtained. This is no reflection upon the micropaleontologist, because one who deals with the larger invertebrate fossils can do no better, since

> ". . . Organisms usually are geographically restricted in their ranges, and those of one area are not suited for comparison with those of another area in which they do not occur." ((6), p. 688).

But what makes correlations over wide areas possible or impossible when fossils are employed? Dispersal of organisms is, of course, the answer. The dispersal of marine invertebrates takes place chiefly during their larval stages. Most of them, although bottom dwellers when adult, pass their larval stages as part of the marine plankton. The Recent common mussel (*Mytilus edulus*) passes through a comparatively long free-swimming stage—long enough to be dispersed many miles if currents are strong. Its spawning temperatures are from 50° to 53.6° Fahrenheit (5). The duration of the free-swimming larval stages of some corals has been determined as from a few days to as much as three weeks ((6), p. 689). That the young of viviparous echinoderms play an important part in extending their geographical range has been stated by Agassiz (7). The conclusion is that the longer the free-swimming stage and the greater the range of spawning temperatures, the greater will be the dispersal, environmental conditions and other factors permitting.

EXPLANATION OF PLATE 26

The single horizontal lines indicate depth of water, each division being 100 fathoms. The double horizontal lines give the arbitrary divisions of the halobios into the neritic, bathyal, and abyssal zones.

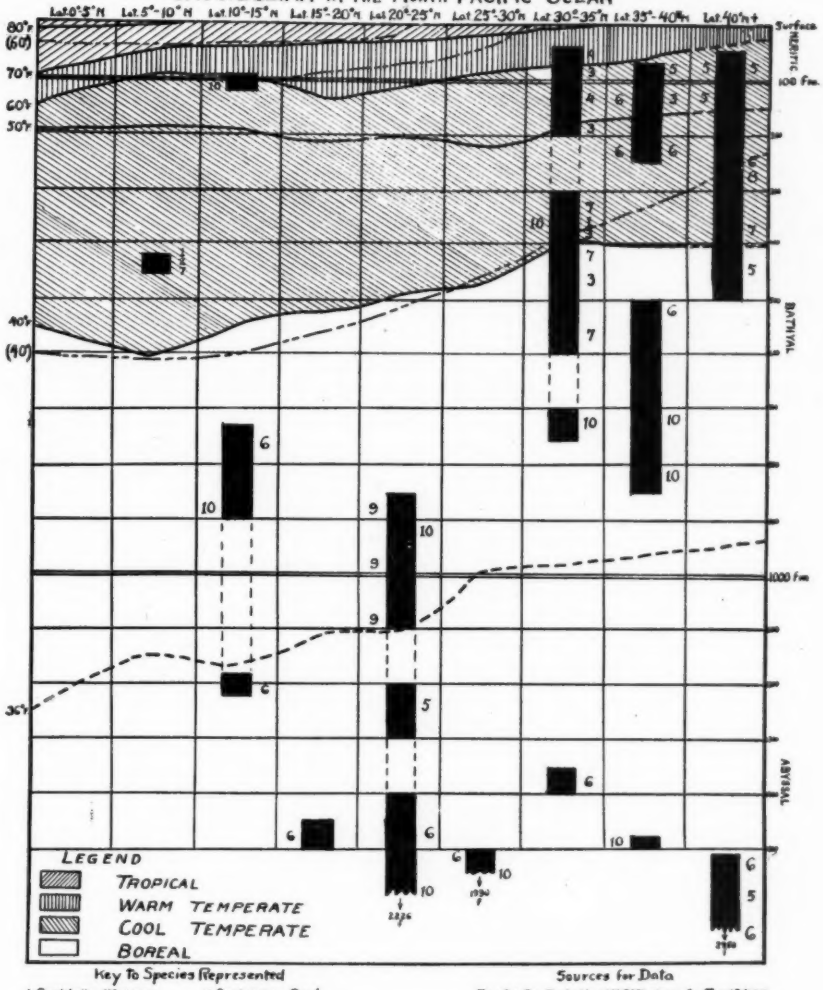
The vertical lines represent latitudes. The first line on the left is the equator.

Isothermal lines, based upon statistics in the "Challenger" Report, extend as irregular lines (marked 60° F., etc.) across the chart, and the ruling gives a customary classification of the oceanic temperatures into so-called climates, tropical, warm temperate, cool temperate, and boreal. Both the estimated minimum and mean temperatures are shown. The approximate bottom temperature at a given latitude and depth may be found by interpolating between the isothermal lines. For example, the bottom temperature at latitude 15° north and a depth of 900 fathoms would be about 38° F.

The distribution of species of *Cassidulina* is illustrated by the index numbers to the right and left of the vertical columns. The numbers to the left explain that the species occurs on the western side of the north Pacific ocean (in the Oriental region) and the figures to the right of the column name the species that occur on the eastern side of the ocean from Alaska to Panama. The species are: (1) *pulchella* d'Orbigny, (2) *corbyi* Cushman and Hughes, (3) *limbata* Cushman and Hughes, (4) *tortuosa* Cushman and Hughes, (5) *crassa* d'Orbigny, (6) *subglobosa* Brady, (7) *delicata* Cushman, (8) *laevigata* d'Orbigny, (9) *elegans* Sidebottom, and (10) *C. (Cassidulinoides) bradyi* (Norman).

In interpreting this chart, it must be borne in mind that there is an upwelling of cool, eastward moving waters along the California coast. Map 3 in reference 10 shows that the mean temperature at a depth of 100 fathoms along the California coast does not exceed 50° F.

GEOGRAPHIC, BATHYMETRIC, AND THERMAL DISTRIBUTION OF THE GENUS CASSIDULINA IN THE NORTH PACIFIC OCEAN



Key To Species Represented

1. C. pseudoclavata d'Orbigny
2. C. barbieri Cushman & Hughes
3. C. insolata Cushman & Hughes
4. C. tortuosa Cushman & Hughes
5. C. crassa d'Orbigny
6. C. subglobosa Brady
7. C. delicata Cushman
8. C. laevigata d'Orbigny
9. C. elegans Sidebottom
10. C. (Cassidulaneides) bradyi (Norman)

Index number to left of column = Western area.
Index number to right of column = Eastern area.

Sources for Data

Rep. Sci. Res. Exped. Vessel H.M.S. Challenger, pt. II, vol. I (1885)
U.S. Nat. Mus. Bulletin 71, pt. II (1911)
Bull. Scripps Inst. of Oceanog., Tech. Ser. vol. 1, no. 10 (1927)
Rep. U.S. Nat. Mus. for 1895, pp. 479-549 (1897)
and other publications

——— Minimum Temperature.
— — — Mean "
- - - - - - Approximate "

That the larvae of a marine invertebrate which is limited to tropical waters could not be dispersed into arctic waters is, therefore, apparent. Thus is explained the fact that the shallow water faunas of these two extreme environments possess such outstanding characteristics.

By a tropical environment one implies the neritic zone of tropical seas, and thinks of such regions as those off the Bahamas, the Bermudas, the Dutch East Indies, the Philippine Islands, and India. Some authors consider that tropical waters are those that are 70° F. or warmer, warm temperate from 60° to 70°, cool temperate from 40° to 60°, and boreal below 40°, as shown in Figure 1. (Consult also (8)). The facts that water temperatures at the equator may differ exceedingly according to depth, and that a shallow water species of the high latitudes may retain its cool water environment in low latitudes by seeking depth, are generally recognized (9). The distribution of *Cassidulina*, shown in Plate 7, illustrates this retention of a cool environment by changes of bathymetric range.[2] In general, shallow water tropical faunas are distinguished by an abundance of species, in contrast with a great number of individuals per species. Such Foraminifera as *Peneroplis*, *Archaias*, *Orbitolites*, *Alveolina*, and *Amphistegina* favor warm seas. The nullipores are also important. Although the common incrusting calcareous alga which occurs as red coatings on our coast today—the genus *Lithothamnion*—lives in cool water and although thick algal incrustations occur off Nova Zembla and other points within the Arctic Circle, nevertheless the nullipores are great reef-builders only in the tropics (11). *Lithothamnion*-limestone indicates in most instances a shallow, warm water facies. Moreover, an idea of the Foraminifera that are found in deeper water deposits of the equatorial regions may be gained by an examination of Murray and Lee's report on "The Depth and Marine Deposits of the Pacific Ocean" (12), supplemented by Nuttall's notes on the localities of the "Challenger" Foraminifera (13) and Cushman's numerous papers. Among the forms recorded from deep water, the most frequently occurring species belong to such genera as *Rotalia*, *Cristellaria* (of authors), *Haplophragmoides*, *Gaudryina*, *Cassidulina*, *Lagena*, and *Nonion*. Whether these were sometimes carried there by external agencies or were autochthonous to the place where found is not known, but their presence is at least

[2] For a table showing the mean temperatures of the ocean from 100 to 2,200 fathoms, consult (10). Map 3 accompanying this report shows the isothermal lines for the depth of 100 fathoms. It is significant that in the North Pacific the highest temperature (70° F.) isothermal for the 100 fathom depth is situated in the middle and western Pacific, whereas the coast from British Columbia to Lower California falls between the 40° and 50° isothermals for the same depth.

suggestive of forms that prefer cool temperatures. Cushman has pointed out (14) that arenaceous Foraminifera predominate in the deep-sea forms. (Consult also Chapman (15)).

The shallow water fauna of the polar seas having normal salinity stands in decided contrast to that of the tropics. In this the number of individuals per species is greater than in the tropics, whereas the total number of species is smaller. Rate of growth is slower in cold waters, but the individuals often attain larger sizes. The arctic shallow water foraminiferal faunas are characterized by an abundance of arenaceous Foraminifera, especially *Reophax, Haplophragmoides, Saccammina,* besides *Cassidulina, Globigerina pachyderma, G. borealis, Nonion scapha,* and *Elphidium sibericum.* In the interpretation of a fossil fauna, a predominance of these forms would suggest cool waters during deposition.

These two briefly sketched examples represent designedly two extreme cases. The cool water fauna is unlike the contemporary one from warm seas, and we could not correlate them on the basis of species in common. Yet recall the statement regarding an abundance of Cassidulinas indicating Pliocene age. Does not an abundance of such forms indicate merely cool waters, instead of contemporaneity? Examination of Plate 26 demonstrates that the Recent West Coast species of the genus have their optimum in cool temperate and boreal waters. "Abundant Lepidocyclina indicates Oligocene" is another such statement. ((3), p. 566). This is a tropical genus and abundant specimens of it may indicate Oligocene in the Americas, but not necessarily Oligocene in European and Malaysian regions, where it is also abundant in the Miocene. Moreover, Oligocene rocks of a different and extra-tropical province would lack this genus.

Within each of the major divisions of the marine environment are subdivisions, comparable to the different local facies frequently observed in sedimentary formations. In the Tejon Eocene formation of Ventura County, California, the writer has collected specimens of the gastropod genus *Turritella* and a stenohaline echinoid *Spatangus,* from a sandstone deposited under marine conditions with normal salinity prevailing; but only a short distance from the first locality, along the strike of the formation, estuarine conditions are indicated by lithology and fauna. The mutations in the same species of gastropod along this formation may be explained as an effect of changing environmental conditions during the life of the species in that locality.

These observations lead to the major contention of this paper:

that mode of living and environmental conditions should be considered seriously in utilizing species of fossils for recognizing differences in time. Faunas that are similar on account of adjustment to similar conditions of environment are *homeotopic* faunas, whereas those that are normally adjusted to different types of environment and have no genetic relationship to each other are *heterotopic* faunas (16). The stratigraphic paleontologist collects faunules from various horizons in a geologic column and plots the ranges of the species. If the vertical distribution of a certain number of species ends at a certain point in two localities, he is apt to designate this a "faunal break" and utilize it in correlations, without considering what environment is indicated by the fossils. It would be a more reasonable procedure for him to determine not only the stratigraphic distribution of the species but also the ecologic conditions that prevailed during the time the two faunules existed, since unlike faunas may be of similar age and similar faunas may be of different age. If determinations prove that, in a local basin, the various epochs of deposition are characterized by definite ecologic conditions (that is, if the "climatic breaks" are constant in the column), the paleontologist might attach some value to such changes for purposes of local correlation. However, since the differences in homeotopic faunas are due to evolutionary changes or to loss by destruction and gain by immigration of new species (16), it is those faunas which should possess the greater chronologic value.

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REVIEW

CARL O. DUNBAR and G. E. CONDRA, "The Fusulinidae of the Pennsylvanian System in Nebraska", Nebr. Geol. Survey, 2d ser., Bull. 2, 135 pp., 13 figs., 15 pls., 1927.

This interesting and important contribution to the paleontology of the Pennsylvanian rocks of Nebraska not only carries published knowledge in this field a long step forward but affords to students of the Foraminifera and to workers on the Carboniferous the world over, a scholarly and illuminating treatise on the morphology, structural significance and classification of this oldest family of complexly shelled protozoans. The wide distribution of the Fusulinidae, their abundance and increasingly recognized significance as index fossils make the usefulness of this clearly written paper correspondingly great. This is more true since neither from biologic nor geographic and geologic viewpoints is the scope of the authors' attack restricted to the area designated in the title, though much of the material investigated was gathered in Nebraska. It is not the first monographic treatment of North American fusulinids, but it is undoubtedly the most broadly inclusive and valuable work on American fossils of this group that has appeared. With the excellent paper by Beede and Kniker on *Schwagerina*, it places the study of the Fusulinidae in this country on a firm ground which has been lacking. Especially to be commended, it seems to the reviewer, is the simplicity of style, clarity of expression and readability of the paper by Dunbar and Condra, so often lacking in a technical treatise of some complexity; these qualities considerably enhance its value for beginning students in paleontology.

The first portion of the work is devoted to a discussion of shell structures, the peculiarly complex organization of the walls, characters of the septa, and other features, several new and useful morphologic terms being introduced. The existence of septal pores in many of the fusulinids is pointed out.

The second section is devoted to consideration of the problem of classification. Generic discriminations of other authors are reviewed in some detail and older classifications are critically examined. A revision offered by Dunbar and Condra based on their careful comparative study recognizes four sub-families and eleven genera, as follows: (1) Fusulinellinae, *Staffella, Fusulinella;* (2) Fusulininae, *Fusulina, Triticites, Schwagerina;* (3) Verbeekininae, *Doliolina, Verbeekina;* (4) Neoschwagerininae (new), *Cancellina, Neoschwagerina, Yabeina* and *Sumatrina.* It will be noted that Girty's genus *Triticites* is regarded as a valid group to which is referred a majority of the well known Pennsylvanian species such as *F. secalicus* Say and *F. ventricosus* Meek and Hayden.

The third portion of the paper is devoted to description of genera and species: *Fusulinella,* four species (three new); *Triticites,* twelve species (six new); *Fusulina,* two species; *Schwagerina,* three species. There are fifteen plates of excellent figures.

One of the most valuable parts of the contribution is a discussion of stratigraphic distribution in which the zonal arrangement of the fusulinid species and their usefulness in correlation is brought out. The known range and distribution of species is represented graphically in a chart. A selected bibliography on the fusulinids is included at the end of the report.

RAYMOND C. MOORE.

REPORT OF THE SECRETARY-TREASURER

During the year between the first and second annual meetings, 1927-1928, the Society of Economic Paleontologists and Mineralogists began to function as an organization. At the same time the publication of the Society, JOURNAL OF PALEONTOLOGY, was started and the first volume, consisting of four numbers, was issued.

The Society's membership on March 15, 1928, consisted of 89 charter members and 17 elected after January 1, 1928. The roster of the membership is given at the end of this report.

Immediately following the Tulsa meeting all efforts were bent toward the success of the Journal of Paleontology. Contract for publication was entered into with the University of Chicago Press. Due to the lateness in the year of the Tulsa meeting, the four numbers of Volume One were somewhat irregular in appearing, being issued in July, August, December and January respectively. The subscription to the first volume exceeded even the most optimistic expectations. An issue of 700 was printed. By the end of 1928 it seems likely that the supply of Volume One will have been exhausted.

In December the secretary asked Donald D. Hughes at Los Angeles to take charge of the program for the Society for the San Francisco meeting. He was assisted by G. Dallas Hanna in San Francisco.

The second annual meeting of the Society was held in San Francisco on Thursday, March 22, 1928, in the Clift Hotel. At this time the annual business meeting was accompanied by the presentation of a program of technical papers.

At the business meeting the minutes of the first annual meeting were read and approved. The following reports were read and approved: editor's report, secretary-treasurer's report, and the audit committee's report. The report of the nominating committee was then submitted. The following officers were elected for 1928-29: president, R. C. Moore; vice-president, G. Dallas Hanna; secretary-treasurer, F. B. Plummer; and editor, Joseph A. Cushman, which with the retiring president constitute the Society's Council for the year 1928-1929.

The following papers were listed on the program, and were either given or read by title:

1. Paleontologic Studies in the Upper Paleozoic, by Raymond C. Moore.
2. Brackish Water Pliocene Diatoms from the Kettleman Hills, by G. Dallas Hanna.
3. A New Fauna from the Cook Mountain Eocene near Smithville, Bastrop County, Texas, by W. Armstrong Price and Katherine Van Winkle Palmer.
4. Micropaleontologic Formational Divisions of the Upper Tertiary and Pleistocene of Southern California, by G. H. Doane and S. G. Wissler.
5. Additions to the list of Species Occurring in the Type Red Bluff, Hiwannee, Mississippi, by Henry V. Howe.
6. Notes on the Paleontology of the Santa Barbara Islands, by Leo. G. Hertlein.
7. A Subsurface Study of the Richfield Oil Field, Orange County, California, by Stanley G. Wissler and George C. Kuffel.
8. Some Notes of the Succession of the Marine Invertebrate Faunas of the Upper Fernando, Ventura County, California, by Edward D. Presslar.

9. Notes on the Miocene Paleontology and Stratigraphy of Columbia, by F. M. Anderson.

10. The Biostratigraphic Aspect of Micropaleontology, by Hubert G. Schenck.

11. Systematic Micropaleontological Research, by Robert M. Whiteside.

12. Microscope and Photomicrographic Technique, by G. Dallas Hanna.

13. A Comparison of the Typical Well Section of the San Fernando Valley with the Los Angeles Basin Section, by G. H. Doane.

14. Some Results of a Foraminiferal Study of the Fernando Group of Southern California, by Paul P. Goudkoff.

15. Presidential Address, The Change in ideas about Foraminifera, by J. J. Galloway.

The meeting was a very successful one, and the retiring secretary, in behalf of the Society and others who attended the meeting, extends appreciation to those who were so responsible for the success of the meeting. The American Association of Petroleum Geologists rendered all possible aid to its success.

The retiring secretary-treasurer has deeply appreciated the support and cooperation he has received from the officers and members of the Society. He has also deeply appreciated the constant help of his assistant Mr. W. G. Parker.

THE FORT WORTH SECTION

The following officers have been elected for the year: president N. L. Thomas and secretary-treasurer Frank J. Stangl.

CONTRIBUTORS TOWARD THE PUBLICATION OF THE JOURNAL OF PALEONTOLOGY ARE THE FOLLOWING:

American Association of Petroleum Geologists
Ralph Arnold
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Floyd Dodson
David Donoghue
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FINANCIAL STATEMENT AS OF MARCH 15, 1928

RECEIPTS

Donations toward publication		$3,275.00	
Membership dues for year 1927	$356.00		
Membership dues for year 1928	48.00	404.00	
Subscriptions to "Journal":			
Volume One	$2,562.86		
Volume Two	698.60		
Volume Three	1.50	3,262.96	
Individual Sales		9.00	
Miscellaneous Receipts		6.40	
Total Receipts			$6,957.36

DISBURSEMENTS

Stamps, Stationery, Printing, etc.:			
F. B. Plummer	$27.30		
Editor	45.31		
Sec-Treasurer	208.00	280.61	
Clerical Services:			
Editor	$240.00		
Sec-Treasurer	70.00	310.00	
Publication of "Journal of Paleontology":			
Vol. 1, No. 1	$1,134.53		
Vol. 1, No. 2	933.57		
Vol. 1, No. 3	779.04		
Vol. 1, No. 4	803.76		
Wrapping, sorting, mailing, etc.	242.65	3,893.55	
Miscellaneous Expense		14.69	
Total Disbursements			4,498.85
Balance in bank, as shown by books			$2,458.51
Plus outstanding checks shown below:			
Mar. 10 42 J. B. Hawley	$.20		
10 43 J. A. Cushman	26.25		
14 44 Univ. C. Press	803.76		
14 45 Chas. Schuchert	2.00		
15 46 Mrs. Irl Allen	3.00		835.21
Balance shown by bank statement			$3,293.72

(Signed) MARCUS A. HANNA,
Secretary-Treasurer.

Audited and approved March 21, 1928.

(Signed) Parker D. Trask
George H. Doane